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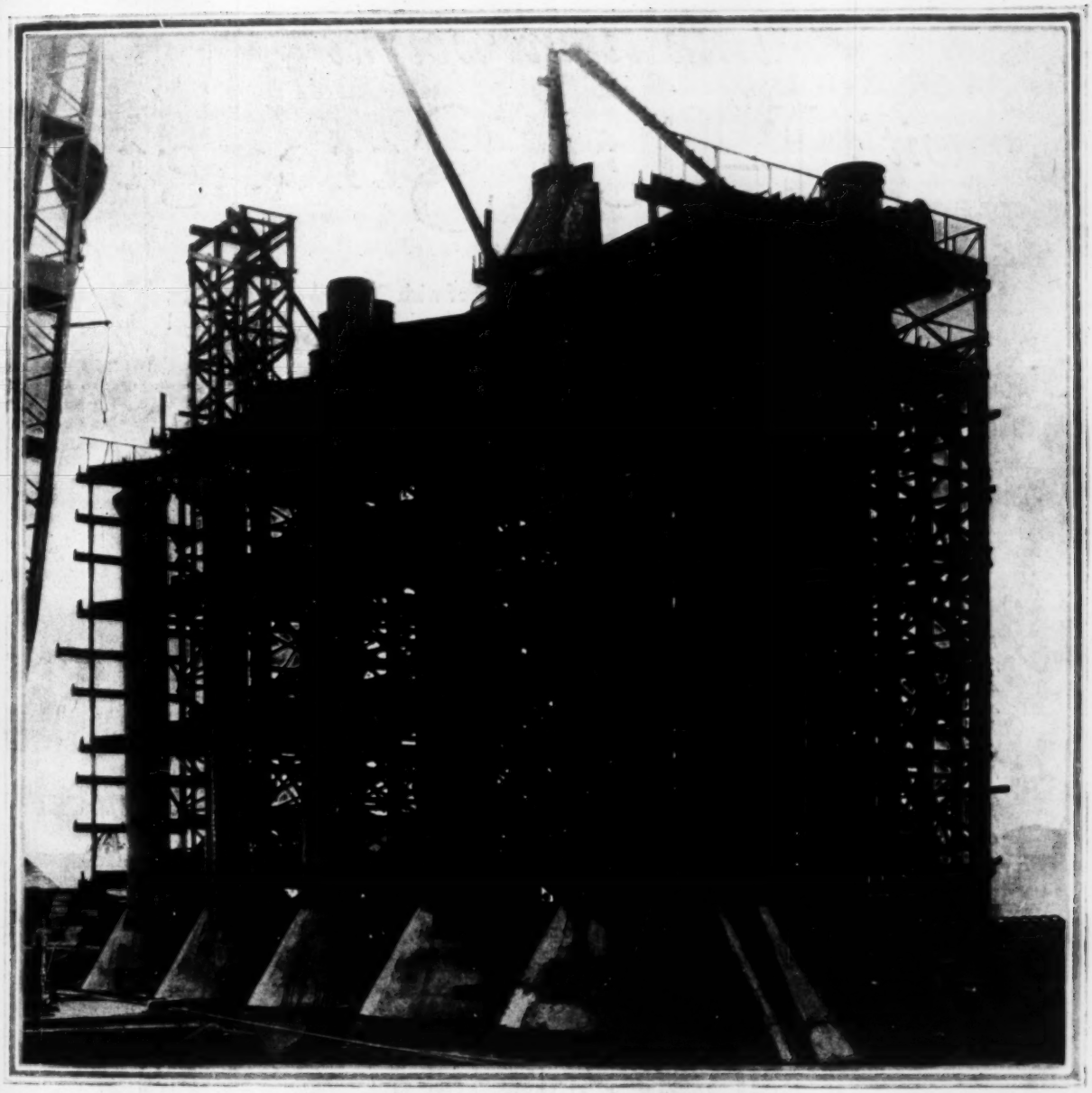
Engineering News-Record



Precast Concrete Shells for Pier Supports, Puget Sound Navy Yard

Navy Yard Pier Supported on Cylinders Having Precast Shells Made with High-Alumina Cement, by Lieut. Commander J. J. Manning and W. F. Way — New I-Beam and Column Sections Produced by Carnegie — Industrial Railways for Factories and Construction Work - I, Tracks for Mills and Warehouses, by E. E. R. Tratman — Report of Annual Meeting of American Concrete Institute

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
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FRANK C. WIGHT
Editor

Volume 98 NEW YORK, MARCH 3, 1927 Number 9

A Personal Note

SEVERAL local engineering societies have taken up a campaign initiated by the Engineers Club of Des Moines looking toward a reform in engineering literature. These engineers are worried about the lack of standardization in "reading matter such as magazines, bulletins, circulars, catalogs, proceedings, etc., with its impossible features in regard to filing for reference, entailing waste of time and energy for small gleaning or search of references." They therefore suggest several reforms, among which are uniform size, arrangement of subjects so as to permit being filed as full sized sheets, and uniform indexing. The suggestion carries the connotation that every piece of engineering literature will be so standardized that the reader, for instance, would know that page two would cover bridges and that each article on bridges would be prepared in the light of a fixed formula of information desired. As a prospective victim of this latest manifestation of the standardization mania this journal ventures a feeble protest. If the making of engineering literature is to be reduced to a system, if individuality is to be subordinated to the file cabinet, if every engineering journal is going to have to look like every other one, we know of several editors who are open to engagement in some less formalized field of endeavor.

Industrial Railways

RAILWAY lines, tractors, motor trucks, overhead monorail carriers and cranes and a variety of forms of conveyors have all been adapted to the requirements of internal transportation which constitutes an essential feature of most industrial and manufacturing establishments. One of these is described elsewhere in this issue in the article dealing with rail transport or plant railways, considered as distinct from the main-line connections required at numerous plants, although forming sometimes an extension of the latter. These industrial railways may range in length from a few hundred feet in or between shops to a comprehensive system serving the entire plant. They represent also a great variety in width of track gage, from 12-in. to 60-in. In the aggregate, railways of this class represent a considerable mileage and an important business in the manufacture and supply of materials and equipment. The article mentioned reviews the purposes of plant railways, their limiting or governing conditions, their track layouts, and their motive power and car equipment, this information being supplemented by examples of practice, some satisfactory aad others unsatisfactory. Furthermore, it is shown that in the interests of both the manufacturers and purchasers of plant railway material it is economically desirable to reduce the numerous widths of gage to a relatively small series of gages, sufficient to meet different necessities and conditions. This article is supplementary to the several articles on industrial plants which have been published in *Engineering News-Record* during the past two years, and is supplementary also to the recent articles on "The Civil Engineer in Industry." The industrial railway as a feature in construction work is included in the present article, since the same type of line is often used for both permanent installations at manufacturing plants and for temporary installations on construction work.

The Slave of the Transit

MAN is always seeking symbols. He wants an easy way of representing complicated human emotions and activities. The flag symbolizes love of country, the sour faced puritan the spirit of moral reform. So the engineer has become the slave of the transit. This simple but necessary instrument has become the symbol of the engineer, because it is something tangible, something peculiar to nearly every kind of engineering work, and because, most of all, it has a certain mysterious quality to the uninitiated. Merely as a symbol no engineer can object to the transit, but this symbolism has offensive implications. Take the well-intentioned tribute to the engineer that we print this week in our "Random Lines" column. To the man who wrote that, and to the house that sponsored it, the engineer is a man who runs a surveying instrument and sees that a building is true to line and grade. Lost are all the contributions the engineer makes to the art of building, forgotten or never known is the fact that the modern building is an engineering structure prettied up by the architect. The engineer is the picturesque gentleman with a pipe who squints through a transit—and gets $28 a week for doing it.

Railroad Valuation Upheld

DISRUPTION of the whole work of railroad valuation has been postponed if not entirely avoided by the finding of the U. S. Supreme Court in the Los Angeles & Salt Lake R.R. valuation case that the Interstate Commerce Commission had not erred in proceeding to fix a "final value" upon the property of all the railroads. Ever since the commission began issuing "tentative" and "final" valuation orders, the railroad companies have protested that its methods and findings were incorrect, were not according to law, or were unconstitutional. In the case in question a district court in California had annulled the order of the commission fixing a "final value" on the property of the Los Angeles & Salt Lake R.R. and had enjoined its use for any purposes. In view of the importance of this ruling to all the other railroads of the country the matter was made a test case and taken to the Supreme Court, many railroads confidently expecting that the court would find the method used by the commission in establishing a value for the Los Angeles & Salt Lake R.R. defective.

thus reopening that case and all similar cases, and thereby at least postponing the date upon which final values will be fixed upon the properties of the various railroads, if not also making it possible to obtain better figures in cases where values already have been fixed. In this they have been disappointed. The Supreme Court ruled upon the *action* of the Interstate Commerce Commission in fixing a final value, rather than upon the *methods used* in determining it and declared that its action was according to law, that it was required to find such a value, and that until an improper use had been made of the value so found, no court had any right to annul the so-called order of the commission fixing the final value. The whole outcome of the case is that the Interstate Commerce Commission is upheld in its claim that it must proceed to determine and fix final values according to its interpretation of the law. A decision as to the legality of its methods must wait until it uses such values in establishing new rates or for the recapture of excess earnings.

Aggregate To the Fore

THROUGHOUT the meeting last week of the American Concrete Institute ran the thread of the importance of aggregate as a major factor in good concrete. This was not planned by the program committee. There was no set group of papers on the subject. But the theme recurred in both paper and discussion. The shape, size, kind, quality and grading of the aggregate and the effect of all these on cost, density and strength of concrete came up again and again. This is significant, for of late there has been a tendency to subordinate everything in concrete making to the cement-water ratio. But concrete is not alone cement and water; its major volumetric content is some kind of stone and the quality and quantity of that stone not only affect the relations of the cement and water which form the binding medium but also the strength, to a degree the density and certainly the durability of the integrated whole we call concrete. This is not a new observation, but it needed emphasis, such emphasis as the speakers at Chicago last week gave it. The study of concrete is moving ahead fast, to the benefit of all who use it. In that study aggregate must take a leading place.

Taking Out the Water

ANOTHER central theme at the Institute meeting, and this too an unintentional one, was the desirability of extracting water from an over wet concrete mix. By the water-cement ratio theory there is an optimum relation of water to cement to produce a maximum strength concrete. But this optimum relation requires an amount of water too small to produce a workable concrete, so the practical effort in proportioning is to put in just enough more than the theoretically proper amount of water to insure a workable mass. The water in excess of that required for full hydration is in effect merely a conveying medium, and presumably if it could be removed once the concrete is in place the process of hydration would be benefited. This is just what is being done in several kinds of concrete work. Mr. Johnson told how he is doing it in concrete pavements, Mr. Earley in stucco and Colonel Longley in centrifugally made concrete pipe. It is the end sought in the several suggestions that the over wet condition frequently noted at the end of concrete runs be cured by final placing of an over dry mix which is intended to suck into it the extra water of the placed concrete and equalize the water content throughout the mass. In reinforced concrete the method is doubtful, not only because of the difficulties of application but because of the danger of drawing concrete away from the steel, but in mass concrete and in thin sections where pressure can be applied or capillary action set up the practice of putting in water to insure workability and then taking it out to insure proper hydration has advantages worth studying.

Chicago in June

ALL signs point to a record breaking convention of the American Water Works Association at Chicago June 6-11. Chicago is near the center of population of the country. A well rounded program is promised. The manufacturers assure ample exhibits and entertainment. Growth in strength and numbers of both the geographical and the technical sections of the association give additional promise of the success of the convention.

Many-Jointed Roads

A FOUR-LANE flexible concrete pavement is described in this issue. The design has been worked out with care and has interest in itself. It is not as a means of meeting a specific problem, however, that the paneled structure arouses thought but as an example indicative of an evident shift of belief from the doctrine of virtually continuous road slabs which grew out of the successful experience of Delaware, Illinois and some others of the early concrete road building states. In the light of this former belief American concrete road builders have looked with a little amusement on the obvious effort of European concrete road builders to multiply joints to avoid cracks and the other phenomena of expansion and contraction. It appears now in some quarters at least that a reversion to European thinking is under way. At least the time seems appropriate to ask whether we are approaching a pavement which is made up of a rather large number of panels or units. In a number of articles which are planned it is proposed to round up outstanding opinion and evidence bearing on this query.

Garbage at San Francisco

SAN FRANCISCO stands alone among the larger cities of the country, and differs from most cities of size and many small ones, in not having its garbage collected at public expense. Householders are dependent on private scavengers for this service, the city doing no more than to establish an elaborate schedule of rates and to maintain a more or less adequate inspection of the collectors. As to final disposal, the system, or lack of system, is equally unusual and contrary to generally accepted principles of public policy. Thirty years ago the city sold to the highest bidder a garbage disposal franchise, which resulted in the construction of a large British type incinerator. To this each private scavenger took his collections, paying the franchise holder for incineration. This plant, old and inadequate, is now owned by the city but operated, rent free, by the scav-

engers. Seventeen years ago a plan was developed for building four incinerators in as many parts of the city and contract was let for two of these. One was built but the city, on the advice of its city engineer, refused to accept and pay for it, alleging non-fulfillment of contract. After a law suit the contractor collected the contract price for the incinerator built but the plant has never been used.

The city authorities claim that the operating cost per ton would be nearly three times that at the old plant and anyway the capacity of the new plant is only 120 tons while the collections are now on the order of 600 tons daily. For some time past the local governing authorities of San Francisco have been dallying with the garbage disposal problem, considering the adoption of the sanitary fill method, of dumping at sea and, recently, of leasing the old incinerator to a company which is said to have offered a yearly rental of $50,000. Pulling and hauling this way and that by various interests, including the private scavengers individually and through a powerful control organization, has made it difficult to effect any change or improvement in method of disposal. The continuation of the private collection system seems also to be due largely to the influence of the scavengers and their friends. It should be remembered that the present system of collection and disposal relieves the city treasury of a considerable annual charge. Householders foot the bill. Whether this is good public policy is open to question—or would be in any other city. Final disposal is another matter. It is more an engineering problem than is collection, but does not seem to be so regarded by the city fathers of San Francisco.

Mysteries of the Air

HUMAN knowledge advances slowly. This truth is easily forgotten in the impulsively rapid surging forward that has been going on in many fields during the last decades and centuries—as most recently in metallurgy, in power, in electrical science and its dependent arts, in the medical field, and the physics of matter. But we may get a fair picture of the infinite slowness of the growth of knowledge by contemplating the science of weather.

Since the age of the earliest nomads and shepherds, men have been scrutinizing the skies and seeking to foretell the course of wind and cloud. Yet today we know little more of tomorrow's rain or sunshine than did the men of the remotest past. Take away the telegraph, and we must still make augury from the strange hues and shapes of the clouds and the feel of the breezes. Even with the telegraph's aid, the refined scientific prediction of the meteorologist is hardly more weighty than the shrewd forecast of seafarer or farmer.

During the month just passed the forces of nature displayed themselves in amazing variety and power. Great earthquakes in southeastern Europe, and destructive storms on the West Coast, the South and the Atlantic seaboard, made violent irruption on the doings of men. We can not foresee these visitations any better than could the ancients in the valleys of the East.

A book recently published sums up the results of a fresh attack on one of the atmosphere's most dreaded phenomena, the great tropical hurricane. For its data it draws on a quarter century of Weather Bureau experience, embracing the labors and minute instrumental observations of hundreds of men at widely different places. Here, surely, we must have the key to most intimate knowledge of what goes on in these vast whorls of storm winds, the secret of their crushing force, their deluges of rain and destructive tidal waves. But the scope of the results disappoints such expectations. We are given perhaps a slightly amended sketch of the trajectories of the storm filaments, within at least that shallow depth of air which the ground observer can gage, but we are still far, it seems hopelessly far, from an understanding of the interplay of vast forces by which these cataclysmic manifestations are set in motion and through which they operate.

Or, again, consider another newly reported fact. During the Maryland tornado of last November a sheet of roofing iron was carried by the storm fifty miles from the focus of destruction, though the storm path itself could be traced on the ground only fifteen miles. Was this mass of metal whirled so far up into the atmosphere that it could travel thirty miles or more by its momentum after the driving power of the tornado stopped? Was there a violent wind current just above our range of view which carried it along like an autumn leaf? Or, perhaps, does a tornado persist even after it has left contact with the ground, and travel for a distance as a pure aerial vortex? Such questions remain dark, as obscure as the meaning of the ups and downs of the barometer, the billows in the sea of air that bring us our weather; or the cold and hot waves, the torrents and the droughts, whose irregular alternation determines our actions and our wellbeing. The mystery of the tornado is not less than that of the larger vortical motions for which meteorologists have pre-empted the term "cyclone," and we are quite as far from having the key.

We live on a shore between earth and air, and the observer of weather works under difficulties, for his measurements do not reach into the centers of force action. This much must be conceded, in extenuation of the continued failure of scientific study to make headway with the problems of meteorological happenings. Undoubtedly, the exploration of the upper air, when it becomes possible, will tell more of the facts and happenings underlying weather phenomena than we now know. Perhaps the useful art of aerial navigation will in time succeed in bringing some of these facts to our knowledge. Airplane and dirigible already have brought to light many strange actions in the lower strata of air, things which no doubt in due time will be correlated with general meteorological knowledge, and the same strange vessels may yet succeed in bringing new knowledge also from higher altitudes. It is too early to foresee what may be expected in this direction; but we are entitled to hope, for science has accomplished but little in seeking to unravel the mysteries of the air by ground observation alone.

Is meteorology a science? Gaged by its results, it seems as yet to be hardly in the stage represented by the period of alchemy and astrology in other fields of knowledge. But on the other side of the matter we may recall the keen remark of Liebig to the effect that there never was any difference between alchemy and chemistry. So, too, our primitive meteorology of today may be the forerunner and initial stage of a future, more effective, science, which will really inform and truly explain. In this possibility lies the hope for an ultimate understanding of weather.

Navy Yard Pier Supported on Cylinders Having Precast Shells of High Alumina Cement

Possibility of Placing Precast Shells in 24 Hr. Greatly Reduced Construction Plant and Handling Costs—Alternate Designs for Pier Submitted by Engineers and Contractors

BY J. J. MANNING
Lieutenant Commander (C.E.C.), U. S. Navy, Bremerton, Washington

AND

W. F. WAY
Construction Engineer, Henry & McFee, Engineers and Contractors, Seattle, Washington

AN UNUSUAL opportunity to study the results of different methods of pier construction is afforded at the Bremerton Navy Yard through the construction of the substructure of piers of some similar design by the use of different methods and materials. Two years ago a description of the methods used in Piers 4 and 5 was published (*Engineering News-Record*, March 13, 1924, p. 436). In the following articles the work on another large pier is described. In the former case, precast concrete cylinders cast in sections support a concrete deck partly precast and partly poured in place. In the latter case cylinders with precast shells of high-alumina cement concrete support a monolithic deck poured in place.

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Requirements and Design

BY LIEUT. COMMANDER J. J. MANNING

INCREASED berthing space at the Puget Sound Navy Yard, at Bremerton, Wash., was provided recently by the completion of a 1,328-ft. reinforced-concrete pier 100 ft. wide. It replaced two 500-ft. timber piers. The new pier is called a repair and fitting-out pier and its object, as the name indicates, is to facilitate the repair of ships which come to the Navy Yard for that purpose or for the fitting out of new ships built in the yard's ship-building dock. Consequently, the pier was built to meet the following requirements: (1) Berthing space for four capital ships; (2) deep water at each berth 39 ft. below mean low water with maximum tide range of 20 ft.; (3) capacity for withstanding very heavy deck loads; (4) locomotive and dry dock crane service to each berth with track connections to shops ashore; (5) foundations for a fixed 350-ton crane; (6) complete facilities for providing all ship services at each berth, namely, electricity, steam, air, salt and fresh water, so that ship boilers and engine room may be completely shut down during repairs. These requirements precluded any consideration of a temporary structure such as a green timber pile pier or a semi-permanent pier on creosoted piles and foundation conditions precluded a solid fill type of pier, although that type would have been very desirable for the support of the large crane. Two existing concrete piers at the Puget Sound Navy Yard are of reinforced-concrete cylinders on timber bearing pile foundations and a design of this type with certain modifications as indicated later on eventually proved the most economical and also desirable.

Preliminary to preparation of the design of the pier, test piles were driven at 150-ft. intervals along the center line and at the proposed location of the large capacity fixed crane. They indicated soil of suitable bearing value at the inshore end at 35 ft. below mean low water, sloping gradually downward toward the outboard end. The depth of overlying softer material varied from zero at the inboard end to 100 ft. at the outboard end, and its consistency varied with the depth.

The deck of the pier was designed for a live-load of 900 lb. per sq.ft. except in the area served by the fixed crane, where it was increased to 1,200 lb. per sq.ft. The three standard-gage tracks, one on each side and

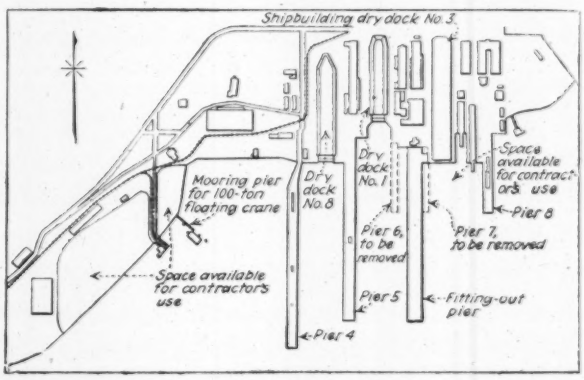


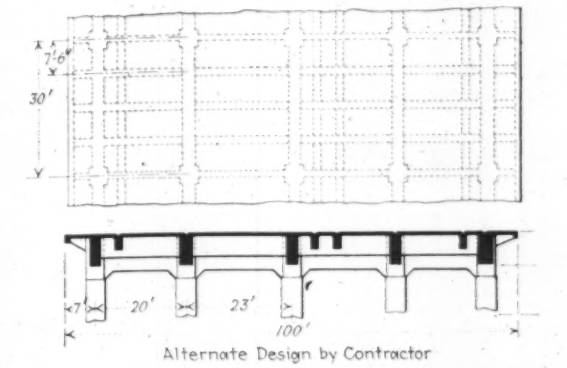
FIG. 1—PUGET SOUND NAVY YARD, LOCATION OF NEW PIER

one on the center line, were designed for two locomotive cranes in tandem with four wheel loads of 60,000 lb. each at 5 ft. 6-in. centers. The two dry-dock crane tracks of 20-ft. gage, one on each side of the pier, were designed for 83,000-lb. wheel loads on each of eight wheels at 3 ft. 6-in. centers. The 350-ton crane is to be supported on a gantry of four legs, resting directly on the pier, each leg with maximum load of 3,000,000 lb.

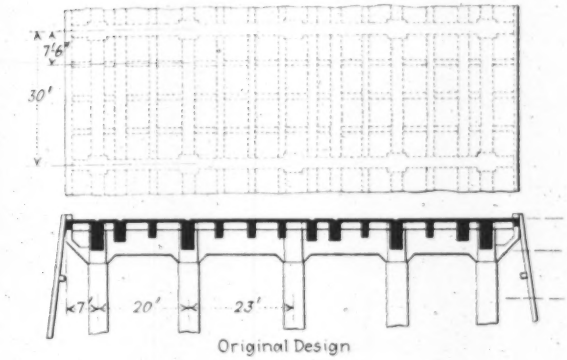
Unit allowable stresses used in the design were 12,500 lb. per sq.in. in reinforcing steel and 600 lb. per sq.in. in 1:2:4½ concrete.

Pier Design—In studies for the most suitable type of pier a reinforced-concrete pile design was developed which proved to be entirely feasible and economical for the inboard half of the pier, but the great length of piles required for the outboard half rendered the handling risk and cost of piles excessive. The final design adopted was of the cylinder type, soil bearing inboard and pile bearing outboard. However, an alternate design of reinforced piles for the inboard half was included in the proposals and bidders were invited to submit bids covering their own design of a pier of equal size, strength and suitability.

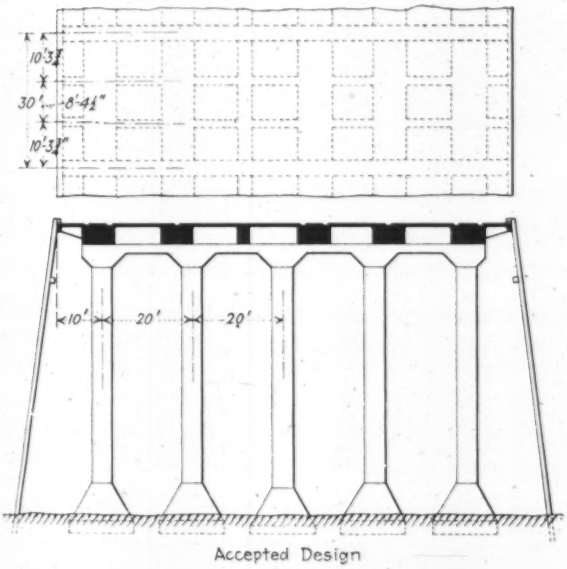
The original design called for a concrete deck with longitudinal and cross girders. This type of deck system naturally possesses considerable lateral stiffness to resist the horizontal thrust of ships in coming alongside the pier, but in order to provide additional stiffness and to prevent any possible damage to the fixed crane (the crane will be 245 ft. high overall, with a maximum boom reach of 190 ft. and a total dead weight of 5,822,000 lb.), an inclined brace cylinder was placed under the support



Alternate Design by Contractor



Original Design



Accepted Design

FIG. 2—ALTERNATE DESIGNS SUBMITTED

for each leg of the gantry crane. Cylinders of the same type and dimensions as the standard for the rest of the pier were specified, set at a slope of 4½ to 12 and supported by 16 timber piles driven to the same slope.

Two cantilever expansion joints were provided in the deck, each joint lugged to transmit horizontal thrusts past the joint.

The specifications provided that the concrete cylinders be constructed of a precast shell 6 in. thick, which shell was to be sunk into place by the pneumatic caisson method, whether supported on hard soil or piles, and filled, in the dry, with concrete. The shells had a shaft 4½ ft. in outside diameter expanding at the bottom to bells 15 ft. 3 in. in diameter to envelop the tops of the timber pile cluster and to provide a wide footing where there are no piles. The length varied from 23 to 60 ft.

Limited Cost—The limit of cost fixed by Congress for this pier was $1,190,000 and as a result various portions of the work were offered for bids as separate items, so that omissions might be made if found necessary to keep the cost within appropriation limits.

When bids were opened it was found possible to complete the structure to the general dimensions contemplated. The contract was awarded to Henry & McFee, engineers and contractors, Seattle, Wash., on an alternate design prepared by their construction engineer, W. F. Way, at a total cost of $1,169,390 for completion in 540 calendar days.

The government design was a typical design and one which could be handled with equipment of ordinary size and capacity. Steel reinforcing was indicated to meet areas required with no attempt to standardize on other than regular commercial sizes. The contractors' alternate design differed from the government's design in the details of the beam arrangement and sizes, substituting one extremely wide girder for two rail girders under the standard-gage tracks, utilizing this same size of girder under the dry-dock crane tracks, and increasing the depth of all panel beams.

Alumina Cement Used—A saving factor in the construction of the cylinders, fostered by the Bureau of Yards and Docks, and one which resulted in reducing cost, was the use of quick hardening, high alumina cement in casting the concrete cylinder shells. By the use of this cement, the necessity of a casting and curing yard was removed and the shells were cast at the pier site in vertical position from a scaffolding erected on one of the existing timber piers. After the shells were in place they were filled with concrete made of ordinary portland cement.

As no information was available to show how the portland cement concrete core would adhere to the high alumina concrete of the shell, tests were made on quarter-size sections of the cylinders to determine the bond strength. The method of making the specimens and the results of the tests are shown in Table I and the drawing. Failure occurred due to bursting of the shell at an average unit bond stress of 172 lb. per square inch, which was considerably in excess of the necessary amount.

The method of handling and mixing high alumina cement concrete was somewhat of a question due to the lack of previous experience in its use, but the work was begun on the assumption that methods of proportioning and testing similar to those used with portland cement would give satisfactory results. Table III gives results of three tests finally selected for consideration. The 1:1½:4 mix was known to contain too much coarse aggregate to permit of proper placing in a reinforced 6-in. annular form 15 ft. deep and consequently the 1:1¾:3¾ mix was used in the first shell poured. This mix proved to be too harsh and was difficult to place. Despite considerable spading and hammering outside of the forms with air hammers, there was not sufficient mortar in the mix to produce a smooth surface and uniform concrete throughout. Consequently, the sand content was increased, resulting in a 1:2:3½ mix. With all mixes, a 6-in. slump was maintained. The 1:2:3½ mix gave a

TABLE I—TEST OF BOND BETWEEN CONCRETE SHELL AND CONE

Cyl. No.	Shell Prop.	Shell Water	Shell Rough*	Shell Poured	Core Prop.	Core Water	Core Slump	Core Poured	Remarks	Total Load	Lb. per Sq.In.	Age	Failure
1	1:1½:3½	7% Vol.	60%	5–29	1:2:4½	5% Vol.	1"	6–1	No allowance for bulking in sand	65,760	760	7 days	Shell split
2	1:1½:3½	7%	40%	6–1	1:2:4	4½%	3"	6–2	Allowance for bulking in sand..	68,680	790	7 days	Shell split 4 places
3	1:1½:3½	7%	20%	6–2	1:2:4	5%	5"	6–3	Sand and gravel wet	51,110	590	7 days	Shell split 2 sides; Comp. failure top core
4	1:1½:3½	7%	25%	6–3	1:2:4	5%	7"	6–4	Sand damp	75,270	870	28 days	Shell split 1 place
5	1:1½:3½	7%	5%	6–4	1:2:4	5%	6"	6–5	3% celite in core	40,530	468	7 days	Shell split 1 place
6	1:1½:3½	7%	15%	6–5	1:2:4	5%	6"	6–6	Sand wet	85,660	1,000	26 days	Shell split 3 places
7	1:1½:3½	7%	5%	6–6	1:2:4	5%	5"	6–7	3% celite in shell	68,050	785	25 days	Shell split 3 places
8													

Note:—Surface between shell and core showed signs of tearing on upper half only.
*That part of surface which was not perfectly smooth due to gravel showing, etc.

more workable concrete and better results, although still requiring liberal spading and hammering. It was used in casting all cylinder shells except those supporting the large crane, where the specifications required not less than 1.75 bbl. of cement per yard instead of 1.5 as required for all other cylinders. This gave a mix of 1:1.9:2.5. All concrete was turned over in the mixer for 1½ min.

The question of curing the cylinders during the 24-hr. period presented no particular difficulty, as the concrete was contained in tight steel forms with no exposed surface other than the tops of the cylinders which were covered with wet bags when necessary. The high temperature developed during setting was quite noticeable, the steel forms being warm to the touch.

The quality of the concrete in the shells was carefully watched, batches too wet or too dry were thrown overboard, slumps were tested frequently and test cylinders broken at regular intervals. The results are shown in Table II. The concrete when broken was found to be hard and dense.

The use of concrete of this character in sea water in this country is of too short duration to indicate its probable life, but it has been used for long periods in strong sulphate waters in Europe with success. Tests of this concrete have been made by placing briquets in concentrated $MgSO_4$ solution and it long outlasted portland cement concrete of the same mixture under similar conditions.

Portland Cement Concrete—The portland cement concrete used in the cores of the cylinders was a 1:2:4½ mix, except in those supporting the large crane, which were 1:1½:3 mix. After the method of placing this concrete under air had been developed, it was mixed with a slump as low as 1 in. The results with this concrete also are shown in Table II. The concrete was dropped from the concrete lock for the full height of the cylinder—varying from 23 to 60 ft.—and on examination after it had set it was found to be of uniform quality throughout, there being no segregation due to the long free vertical drop. As was to be expected, there was a small percentage of minute air bubbles due to the high pressure air becoming entrapped, but these were well distributed.

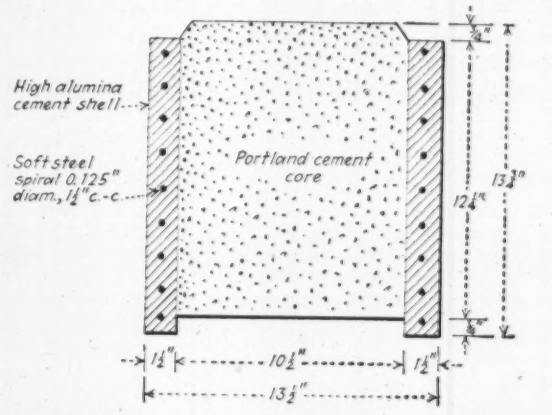


TABLE II—RESULTS OF CONCRETE TESTS

Fineness Moduli Sand	Gravel	Mixtures	
2.85	7.02	1:2:3½ (1:4.26)	$\frac{2 \cdot 2.88 + 3.5 \cdot 7.25}{5.5} = 5.66$
2.94	7.56	1:2:4½ (1:4.76)	$\frac{2 \cdot 2.88 + 4.25 \cdot 7.25}{6.25} = 5.85$
2.82	7.44	1:1½:3 (1:3.45)	$\frac{1.5 \cdot 2.88 + 3 \cdot 7.25}{4.4} = 5.79$
2.87	7.25		
2.54	7.11		
2.92	7.11		
3.20	7.45	1:1.9:2.5 (1:3.53)	$\frac{1.9 \cdot 2.88 + 2.5 \cdot 7.25}{4.4} = 5.36$
20.14	58.01		
Av. 2.88	Av. 7.25		

SUMMARY OF TEST CYLINDERS

Cement	Mix	Age	No. Cyls.	Av. Slump	Av.	Max.	Min.	Location	Per Cent of 28 d.
High alumina	1:2:3½	24 hr.	9	6½	4825	5790	4012	Shells	92
High alumina	1:2:3½	7 d.	16	6½	4642	5350	3118	Shells	88
High alumina	1:2:3½	28 d.	23	6½	5256	7080	3980	Shells	100
High alumina	1:1.9:2.5	7 d.	38	6½	4795	5961	2575	Shells	91
High alumina	1:1.9:2.5	28 d.	19	6½	5257	8005	3095	Shells	100
Portland	1:2:4½	7 d.	33	2½	1741	3433	1130	Cores	54.5
Portland	1:2:4½	28 d.	29	2½	3196	4285	1652	Cores	100
Portland	1:2:4½	60 d.	22	1½	4101	4996	2890	Cores	129
Portland	1:1½:3	7 d.	31	2	2811	3330	1967	Cores	63.7
Portland	1:1½:3	28 d.	31	2	4421	5198	2260	Cores	100
Portland	1:1½:3	60 d.	28	2	5596	6637	3460	Cores	127
Portland	1:2:4½	7 d.	80	4	1516	2252	933	Deck	55.5
Portland	1:2:4½	28 d.	69	4	2726	4265	1160	Deck	100
Portland	1:2:4½	60 d.	60	3½	3548	5086	2171	Deck	130
High alumina	1:1½:3½	24 hr.	3	6½	4352	4893	3754	Shells	74
High alumina	1:1½:3½	28 d.	2	5½	5399	5441	5357	Shells	100
			493 cyls.						

TABLE III—RESULTS OBTAINED WITH VARIOUS CONCRETE MIXES

Proportions	1:1½:4 Cu. Ft.	1:1½:4 Wt.Lb.	1:1½:3½ Cu.Ft.	1:1½:3½ Wt.Lb.	1:2:3½ Cu.Ft.	1:2:3½ Wt.Lb.
Cement	.15	14.1	.15	14.1	.15	14.1
Sand	.225	22.95	.2625	26.77	.30	30.6
Gravel	.60	64.2	.5625	60.19	.525	56.17
Water, cu.ft.	.094	.101	.100	.104	.104	.110
Gal. per cu.yd.	27.5	29.2	29.0	30.0	29.8	31.2
Slump, in.	4	6	4	6	4	8
Vol. fresh concrete cu.ft.	.692	.698	.695	.701	.705	.712
Wt. per cu.ft.	155	154	155	154	153	151
Shrinkage on setting, approx.	.01	.012	.01	.012	.01	.013
Bbl. cement to cu.yd. fresh	1.48	1.45	1.46	1.44	1.43	1.42
Lb. per sq.in. compression 24 hr. (2 cyl.)	4,980	4,340	4,850	4,830	4,285	4,230
Lb. per sq.in. compression 7-day (1 cyl.)	5,735	4,850	5,610	5,140	4,670	5,150

This concrete is protected from the sea water by the 6-in. shell surrounding it.

The concrete for the deck, while of the same mix as the cores, was given a 4-in. slump to permit proper placing in the forms and around the reinforcing steel. The decrease in strength due to the increased water content is shown in Table II. The design strength of this concrete was 2,000 lb. at 28 days and a working stress of 600 lb., while the test strength at 60 days averaged 3,548 lb. per square inch in 6x12-in. cylinders. These cylinders were cast from concrete actually removed from the forms after the concrete was placed and spaded, and it is believed they truly record the actual strength.

The slump used gave good results, except near the bot-

tom of the heavy cross girders where the large quantity of reinforcing steel tended to screen out the gravel. This was overcome by reducing the coarse aggregate per batch with no reduction in cement content, thus giving a concrete of much greater workability and strength.

* * *

Alternate Design and Construction

By W. F. Way

THE problem of determining the most economical design for a pier of this character naturally requires considerable study, and the solution must necessarily vary with the contractor's experience and equipment. It is the problem of determining the design of the minimum cost and involves not only quantities of materials but also unit prices, which unit prices, dependent upon the simplicity and uniformity of layout, upon adaptability to use of contractor's equipment, and especially upon the amount of tidal interference with the deck construction, are factors quite as important as the various amounts of materials involved. In the design which was accepted by the Navy Department, and in accordance with which the pier was built, the above conditions for low cost were all met and fairly well satisfied. The experience gained and equipment accumulated from building Pier 5 and Pier 4 extension (see *Engineering News-Record*, March 13, 1924, p. 436) largely affected and influenced our decision with respect to this pier. The following are probably the most important features in connection with the design and construction of this pier:

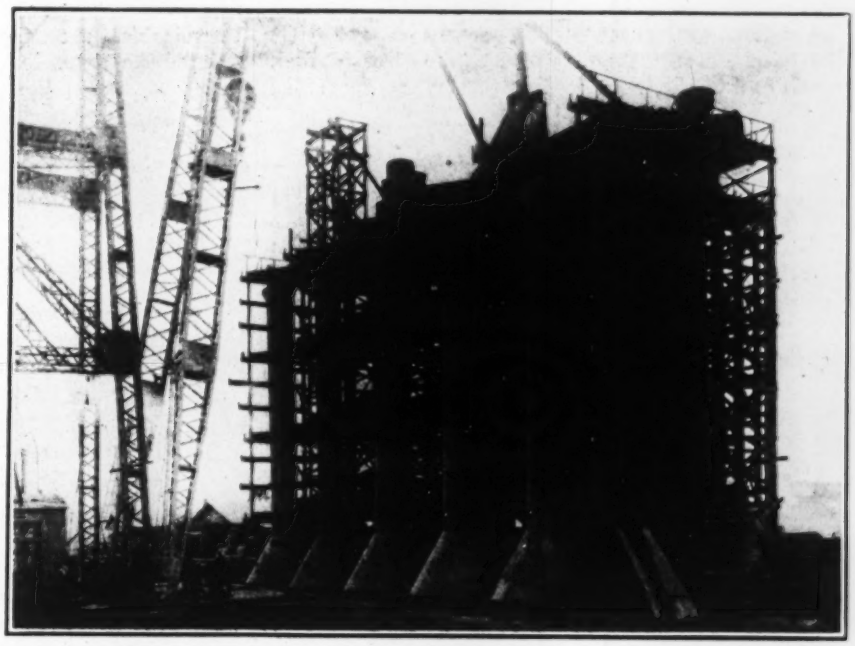


FIG. 3—FIVE COMPLETE SHELLS IN CASTING YARD

Design—Several preliminary designs and layouts were made. The criterion selected by Waddell for economical bridge construction, namely, that the cost of the substructure should equal the cost of superstructure was taken as the basis for comparison. In these comparisons, all constant items, such as fender system, trackage, bituminous carpet, etc., in the superstructure, and the foundation piles in the substructure, were disregarded.

In Pier 4 extension, the actual cost of the superstructure was 1.04 times the cost of the substructure. For the new pier the ratio on the basis of estimated costs was 1.03. Actual cost, however, changed this ratio considerably, due to the subsoil conditions which were considerably more difficult than were anticipated.

The importance of uniformity of construction should be emphasized. While concrete piles were not applicable for use in the outboard portion of this pier, they could have been used in the inshore portion. A combination of concrete cylinders and piles involved, however, two separate and distinct plant layouts, and it was unquestionably more economical to use the cylinders throughout. Aside from cost, it is believed that the cylinder type of construction has added advantages over pile construction, especially where heavy live-loads are to be handled. As a matter of comparison, a 4 ft. 6 in.-diam. cylinder, similar to those used, has the load carrying capacity of eighteen 18 in.-square reinforced-concrete piles. In the piles, there is 3.7 times the amount of steel and 2.65 times the amount of concrete that there is in the cylinder but decidedly more important is the fact that the piles have 6.8 times the surface of exposure between tides that the cylinder presents. Furthermore, it is believed that the concrete in the cylinders, due to the elimination of handling and driving stresses, is in better condition than would have been the case had piles been used. It is safe to say that the cylinders contain practically no cracks, but the same statement with respect to precast concrete piles can not be made with equal assurance. While the minute cracks in reinforced concrete piles have not been proven to be vital and especially when they occur below low water, still the elimination of any cracks in reinforced concrete in sea water should be considered to be advantageous.

In this case it was possible to use high-alumina cement for all exposed surfaces in the foundations. The cost of using the same grade of concrete in piling would have been prohibitive as six times as much cement, or an additional 35,000 bbl., would have been required.

The question of relative cost of repairs between piling and cylinders is a difficult one. If the pier is occupied by a warehouse, replacing piles is difficult while with cylinders the use to which the pier is put makes little difference. On one repair job which we did 22 cylinders were repaired successfully by completely surrounding the old cylinders with six inches of high-alumina cement concrete after all deteriorated concrete had been removed. The carrying capacity of some of the cylinders was increased by placing additional piles under the base.

From a number of layouts studied, two plans were

given serious consideration. They are illustrated in Fig. 2. The quantities for a 30-ft. typical bay in these designs was as follows:

Design	3B	Navy	3F
Concrete, cy.	320	295	285
Forms, sq.ft.	6,000	8,400	7,400
Steel, lbs.	78,000	88,500	72,000
Relative cost	1.00	1.14	1.08

From all available data it was our judgment that design 3B was the most economical. Its principal advantages were as follows: (1) Equal spacing of cylinders in the bents which simplified the temporary bracing to hold them into position until deck was poured; (2) same elevation for bottom of all longitudinal and panel beams; (3) minimum amount of form work which likewise means a minimum amount of surface exposed to the elements; (4) formwork typical (it will be noted that there are but three sizes of deck panels and that all longitudinal beams sides are the same); (5) that practically all form work is above ordinary high water which allowed uninterrupted work; and (6) this design permitted a wide spacing of reinforcing bars with consequent facility for placing concrete.

The fact that all members were of such a size that a workman could easily enter them and clean them out or adjust misplaced reinforcing steel immediately before concrete was poured is of very great importance.

The breadth of the main deck beams, 7 ft., is somewhat unusual. The primary reason for this was to permit the heavy moving standard-gage locomotive crane loads to be carried by one beam. Separate beams under each rail were first considered. With the two beams, however, it was necessary to design each beam to carry the maximum crane load which occurred when the crane boom was at an angle of 45 deg. with the center line of the track. In this position the beam on the side opposite to the boom carried practically no load whatever. It therefore proved much better to combine the two individual beams which naturally resulted in a great reduction of total crane load for the one combined beam over that used for the two separate beams. The tendency for torsional stresses in the one beam when practically the total load was on one rail, was counteracted by the cross panel beams. A secondary benefit arising from the use of this wide beam is the fact that 35 per cent of the uniform live-load was carried directly to the cross girders. The width of the main beams likewise materially reduced the span of all transverse beams.

Round deformed bars 1½ in. in diameter were used for all main tensile reinforcement and all stirrups in the main members were either ¾ in. or 1 in. round. The use of these sizes reduced the number of bars to be handled to a minimum and afforded better embedment and placement.

In general, reinforcing bars were placed in one layer at 4-in. centers. Where two layers of bottom steel were unavoidable, the concrete was made richer and workmen entered the forms to spade and tamp around the bars. This was made possible by the large beam sections used.

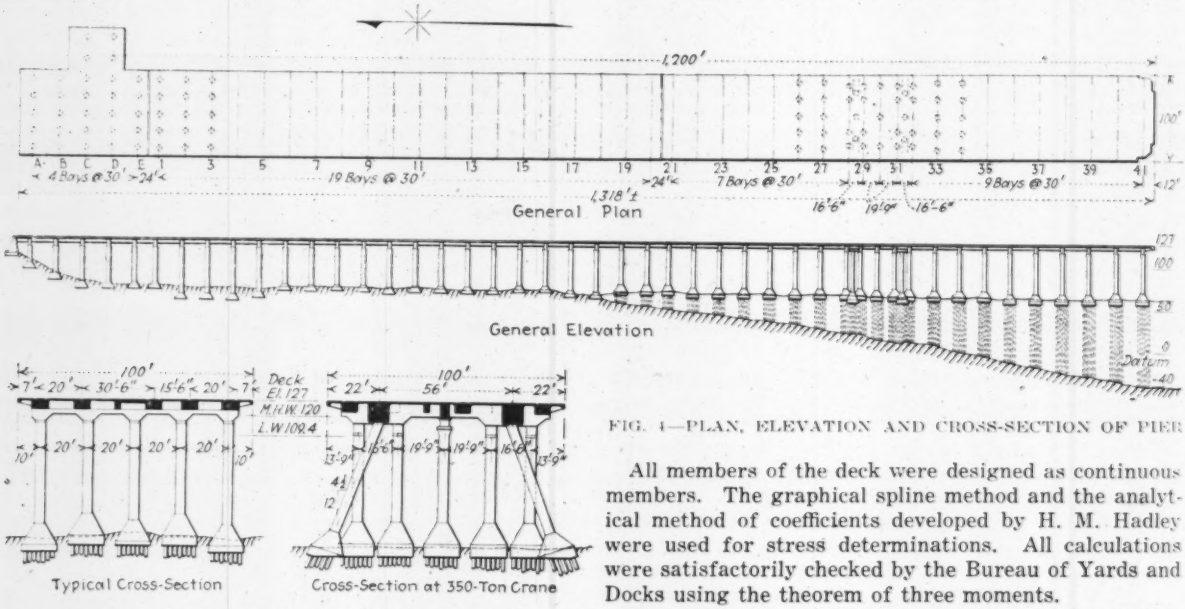


FIG. 4—PLAN, ELEVATION AND CROSS-SECTION OF PIER

All members of the deck were designed as continuous members. The graphical spline method and the analytical method of coefficients developed by H. M. Hadley were used for stress determinations. All calculations were satisfactorily checked by the Bureau of Yards and Docks using the theorem of three moments.

Pile Foundations—Pile foundations were handled in the same manner as on the previous piers referred to above. On the outboard end piles up to a length of 107 ft. were used. Due to the very soft overlying material on the bottom these piles would settle approximately 50 ft. under the weight of pile follower and hammer. They were driven to refusal with a 5,000 lb. hammer and 60 ft. steel follower.

Soil Bearing Cylinders—As stated above it proved economical to use cylinders throughout. It was necessary due to character of subsoil, to use soil bearing cylinders in bents 12 to 18 which the design contemplated being pile bearing. According to the design the piles for these bents would have been 6 to 15 ft. long and it proved impossible with a follower to drive such short piles and keep them plumb and in position. In the writer's opinion, for this kind of construction and similar subsoil pile lengths should not be shorter than 20 ft.

Cylinder Design and Construction—The cylinder shells for this pier were originally designed in portland cement concrete and it was the intention to cast them in a manner similar to that used for Pier 5 and Pier 4 extension. The change to the use of high-

alumina cement was made after the contract was awarded, and resulted in a reduction in the contract price. Full credit for this change is due to the Navy Department which had previously investigated the material and satisfied itself as to its fitness for this work.

The use of high-alumina cement for the cylinder shells meant an immediate increase in cost of shells over portland cement of $45,000 and the question may well be asked "where is the saving?" It was effected as follows: The portland cement cylinder shells required the use of an elaborate casting and assembling yard located three-fourths mile from the pier site and consequently another complete mixing plant would have been necessary. The method used on the earlier piers, of casting the bell sections and cylinder shafts, would have been employed and the labor of tipping and turning the sections, rolling them onto the skidway, assembling them, pouring splices, launching and carrying them to the pier site would have been required. The stresses induced by early handling required a material increase in reinforcement and shell thickness in the bell sections as likewise did the splicing of the sections.

In contrast with this, the use of high-alumina cement permitted the entire 234 cylinders required for the job to be cast on a small timber pier 20x100 ft. immediately adjoining the work and also permitted the stripping of forms and immediate installation in the pier when the cylinders were but 24 hours old. The adopted method of casting the bell and cylinder shaft in a vertical position in one complete unit, and the handling method employed permitted the precast sections to be of minimum thickness and reinforcement, and netted a considerable saving of these materials. Certain hazards were naturally involved in this previously untried operation but the advantages to be gained seemed sufficient to warrant the adoption of the design and method of construction and it was therefore selected. In actual results the use of the high-alumina cement and the above described method for casting cylinders fully justified the contractor's early decision regarding them.

The small casting pier, as stated above, was 20 x 100 ft. in plan. On this, covering almost the entire area and extending over an existing timber pier for 25 ft. was erected a working tower 60 ft. high with four platforms at different elevations. A 12-in. stiff-leg derrick with 60-ft. boom was erected on top of the tower. By means of this derrick all the forms were handled and the previously assembled skeleton cages of the reinforcing steel were placed in position and all additional reinforcement was handled. On the water side of this tower and pier were five bays in which the cylinders were cast and from which the floating stiff-leg derrick swung them into the water with only a few inches lift and then carried them to the site. Forms were provided for five complete cylinders. Inside shaft forms of steel were made in one unit and constituted a hollow cylinder 3 ft. 6 in. in diameter, 45 ft. long. This was cut for its entire length along one element. When the concrete was being placed this form was maintained in true circular section by wedges. To remove it the wedges were struck and it was contracted by means of turnbuckles. The outer shaft forms were made of semi-circular section of about 15-ft. lengths. The outer bell forms were likewise of semi-circular sections. To provide for the necessary adjustment in the "skirt" or vertical portion of the bells, the bottom of the bell forms were cut into horizontal sections.

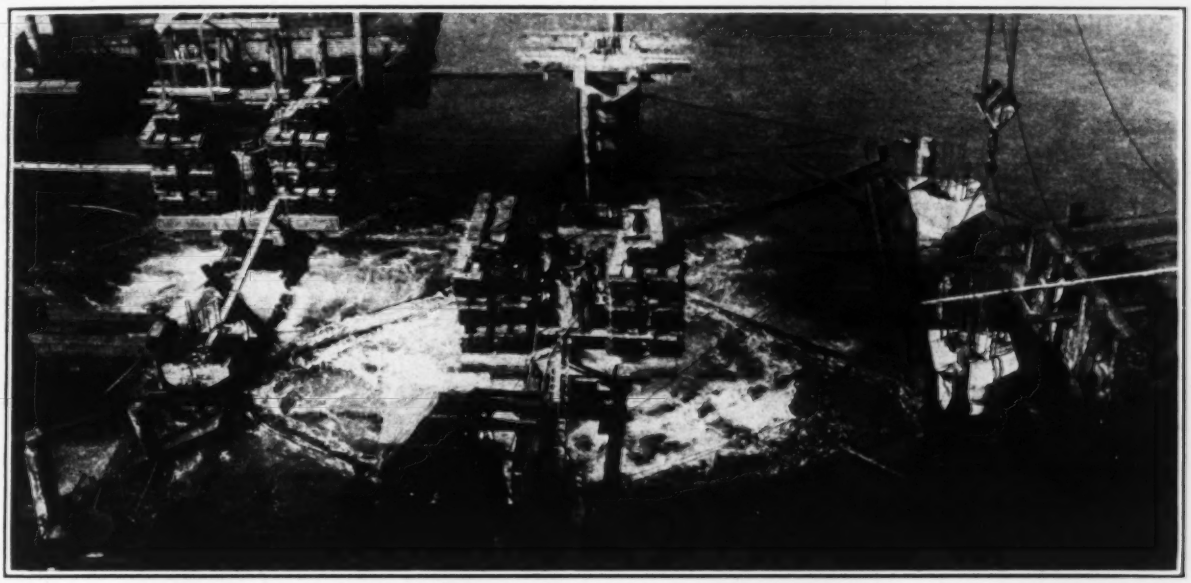


FIG. 5—SETTING CYLINDERS BY PNEUMATIC PROCESS

The success of this method of cylinder construction hinged upon two vital factors, the first of which was the ready and easy removal of the inside bell form, and second, was making this form of such a shape and section as to permit one form to accommodate itself to six different changes in the vertical height of bell sections. On the previous jobs the height of the bell section had been kept constant and the bell diameters varied to suit the pile clusters. By holding the outside bell diameter constant, however, and by varying the height of the bell section the same result was accomplished without the use of any additional material and with great simplification of work and saving in cost.

The inner bell forms were made of wood and covered with sheet metal. Only one set—5 in number—was used on the job. The deck of the casting pier contained circular holes to allow the removal of these forms by lowering them into the water where they floated freely until required again. When in use they were supported at desired height by dogs which framed into the deck structure. This feature worked admirably and contributed largely to the success of the cylinder construction.

The concrete was mixed on a floating mixer and handled from there by bucket to a concrete hoist which elevated it to the desired platform. From there it was taken by buggies and dumped into the forms at two places diametrically opposite each other where it was tamped by rods and by vibrating the forms with pneumatic hammers. These hammers were used both inside and outside; however, inside hammering and tamping was found to be adequate and less expensive.

Forms were removed in 16 to 20 hours, and 24 hours after the concrete had been placed these large cylinders, weighing on an average of fifty tons, were rigged with cable chokers 15 to 20 ft. above their tops, lifted a few inches above the pier deck by the floating derrick which then, with its load, backed clear of the pier to lower the cylinders into the water. The cylinder was then either stored or taken directly to the pier a few hundred feet away. An average of two cylinders complete per day was maintained with the above plant and equipment.

The cylinders were set in place with the same floating stiff-leg derrick used in removing them from the casting pier. The general design of the bracing system to hold the cylinders in line after being set was practically the same as employed during construction of Pier 4 extension. The pneumatic method employed in sinking the cylinders and pouring the cores with concrete was also similar to previous methods used. The air lock and concrete locks however were greatly improved, especially the concrete lock which was enlarged to hold a full mixer batch and was attached directly to the top of air lock.

Falsework for Deck—In designing the deck, the system of falsework and method of handling forms was given considerable thought. All work however, was based upon the idea that the only logical plan was to carry all construction loads by the cylinders themselves as was done in Pier 4 extension. By casting the cylinders with an enlarged rectangular top and at a very trifling expense they were made suitable for this purpose.

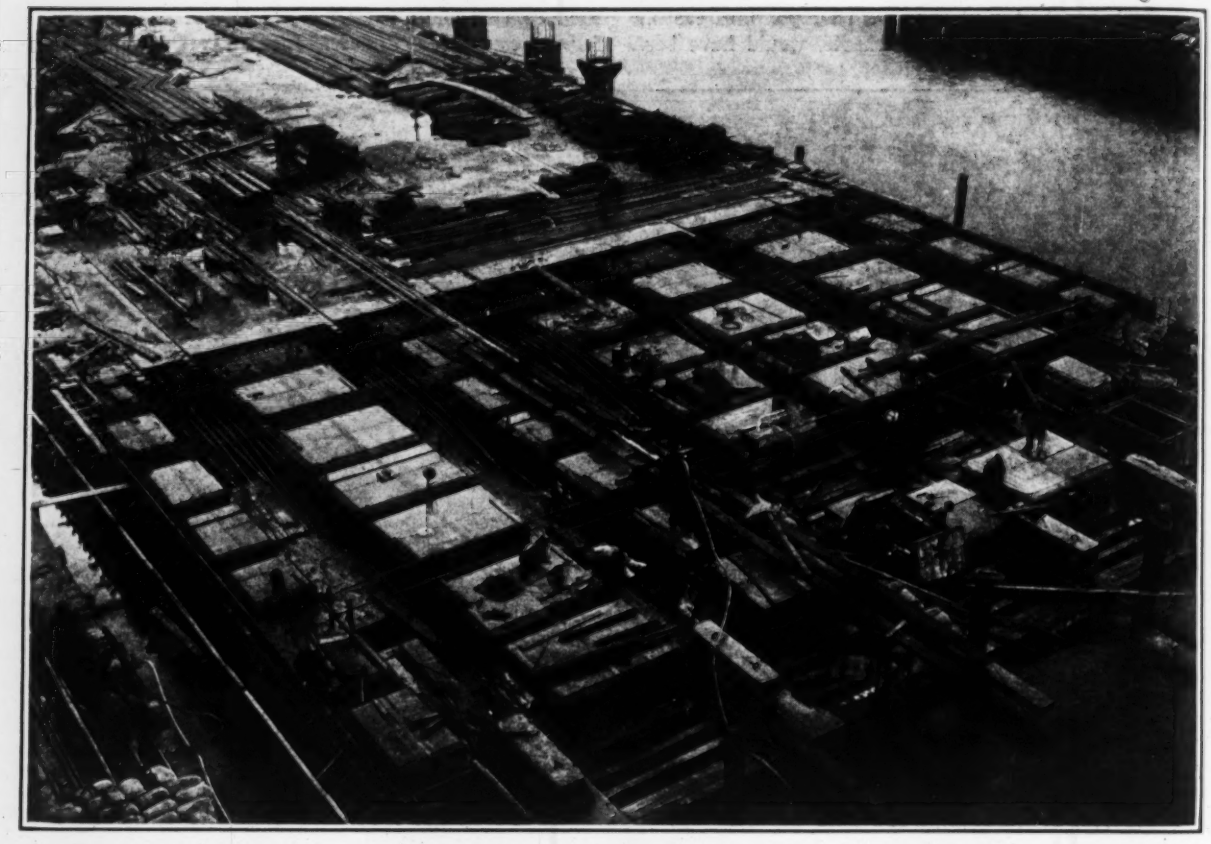


FIG. 6—FORM WORK FOR PIER DECK
Note heavy stringers in foreground. Concrete was placed with buckets.

On the enlarged pier tops were seated heavy trussed beams spanning from bent to bent, a distance of 25 ft. center to center of bearings. These trussed beams did not bear directly on the cylinder tops but on wooden bearing blocks 12x12 in. by a few inches in height, which variable dimension provided the necessary adjustment in final elevation of the cylinder tops. The bearing blocks were the key to the entire formwork system since, by splitting them out the form system was dropped and released. The trussed beam was made up of two 6x16-in. timbers trussed with a 2-in. round rod. The maximum load on the trusses was 140,000 lb. at which time the rods were stressed to 20,000 lb. per

sq.in.; the deflection was negligible and no signs of distress were observed in any part of the truss.

With the trussed beams in position a complete deck of 8x18-in. timbers 20 and 34 ft. in length, 18 in. on centers, were laid spanning across them. The use of such large timbers may be questioned as it was necessary to have a sufficient number for eight bays in order to maintain the pouring schedule. However, it is believed that a close study will vindicate their use,

FIG. 7—UNDER SIDE OF PIER AT CRANE FOUNDATION
Deck forms were supported on shoulders and top of cylinders

especially when it is realized that they entailed no framing or maintainance charges whatever, that they were capable of being freely, even roughly handled with the floating derrick, that they were very simple to place, and that at completion of work they were found to have a very considerable salvage value. Directly on top of the 8 x 18-in. floor the deck forms were placed. Progress demanded forms for about one-sixth of the entire structure and this amount with ordinary minor repairs proved sufficient for the job. All forms were made in panels and handled mostly by the small floating derrick. The deck concrete was poured with two floating mixers, one on each side of pier.

Personnel—The general plan of the pier was determined in conjunction with the Bureau of Yards and Docks by the Navy Yard under the direction of Captain E. R. Gayler (C.E.C.), U. S. Navy, then Public Works Officer at the Yard. Admiral L. E. Gregory (C.E.C.), U. S. Navy, Chief of Bureau of Yards and Docks, approved the alternate design submitted by contractor after it had been checked by Commander Greer A. Duncan (C.E.C.), U. S. Navy, project manager. The construction was prosecuted under the general direction of Captain Walter H. Allen (C.E.C.), U. S. Navy, public works officer. The construction details and all inspection work was done under the immediate charge of Lieutenant Commander J. J. Manning (C.E.C.), U. S. Navy, who was assisted by E. C. Jack, associate engineer.

In the testing of the concrete specimens J. D. Blackwell, city engineer, Seattle, co-operated.

For the contractor, J. P. Mackenzie was general superintendent, M. J. Uhrich was in charge of all cylinder casting operations. The bending and placing of all reinforcing steel was sublet to C. O. Larson. W. F. Way, construction engineer, designed the pier and determined the construction methods and details.

Echo Reservoir to Be Built

FOLLOWING the execution of contracts between the Department of the Interior and organizations of water users, providing for repayment of cost, the Secretary of the Interior has reported to the President that the construction of the Weber-Provo reclamation project in Utah is feasible. The President has approved the report and the project will therefore proceed.

Its central feature is a storage reservoir of 74,000 acre-ft. on Weber River near Echo, Utah, to be called the Echo reservoir. The dam will be an earth embankment of 125 ft. maximum height and 1,800 ft. length, with water face riprapped 4 ft. thick, containing about 1,400,000 cu.yd. of material. The spillway will be able to pass floods of 15,000 sec.-ft., while the outlet works will have 1,200 sec.-ft. capacity. Some 25 miles upstream a diversion canal will be excavated from the Weber to the Provo River, a length of about 8 miles, capable of carrying 200 sec.-ft. This canal will divert water from the Echo reservoir storage to the Provo River to increase its low-water flow. Thus, the storage of the Weber River flood waters will provide a supplementary dry weather supply to irrigators on the lower courses of both the Weber and the Provo.

The cost of the works will reach $3,000,000. Some 80,000 acres of irrigable land lying at an altitude of 4,000 to 5,000 ft. will be benefited, making the cost about $40 per acre. All of the land is now settled and farmed and is producing good crops.

This is virtually the first federal reclamation project dealing with land all of which is privately owned and all under cultivation. The land was originally given up mainly to grain and alfalfa, for which purpose flood-season irrigation was satisfactory. Now, vegetables and similar crops are grown and late irrigation is needed.

The Weber-Provo project is part of the group of irrigation schemes investigated by the Bureau of Reclamation some years ago at the request of Utah interests, known as the Great Salt Lake Basin project. Investigation of the group indicated that the Weber-Provo unit was its most attractive element. Under congressional authorization and appropriations for construction of the Great Salt Lake basin reclamation project, the Bureau requested the local interests to decide upon the unit first to be undertaken, and they selected the Weber-Provo unit. Since then the work of executing contracts with the water users has been in progress, and the present declaration of feasibility follows their successful execution.

Relocation of a section of the Union Pacific R.R. and of the Lincoln Highway will be necessary because of the reservoir construction.

Oil Well Exceeds 8,000-Ft. Depth

Recent developments in deep drilling rotary equipment have made it possible to put down oil wells to greater depths than ever before, according to the "Standard Oil Bulletin," which refers to a well in California being drilled by the Chanslor-Canfield-Midway Oil Co. that now reaches a depth of 8,046 ft. and is still going down. This is said to be the deepest well in the world at present, but the records have been advanced frequently in recent years and the *Bulletin* says: "It is not unreasonable to suppose that the future will see wells 10,000 or 15,000 ft. deep."

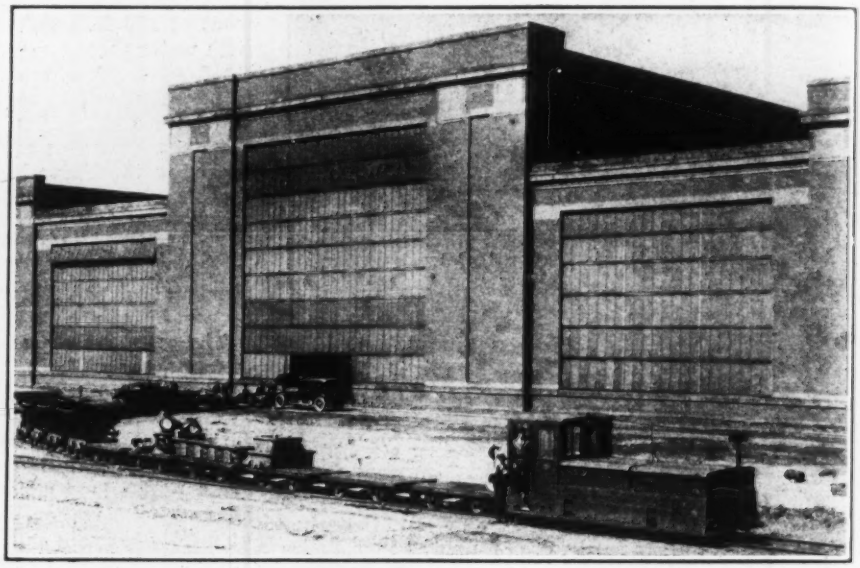
First of Two Articles on Requirements and Use of Industrial Railway Lines

Industrial Railways for Factory and Construction Work—I

Standard and Narrow-Gage Trackage for Mills, Warehouses and Manufacturing Plants—Track Layout and Equipment—Greater Uniformity of Gage Desirable—Construction Tracks

By E. E. R. Tratman
Western Editor, *Engineering News-Record*

RAILWAY transportation facilities provided at manufacturing and industrial plants and on many construction works are of two distinct classes: (1) Connections with main-line railways for receiving and shipping goods; (2) industrial or plant railways for inter-department service. Since these facilities are important factors in the progress of the work it is essential that in each case they should be designed to give efficient and economical service. Standard-gage connections and sidings are required at most large plants. But whether these tracks should be extended through the plant for service purposes, or should be supplemented by a system of narrow-gage tracks for such purposes is a matter which must depend largely upon local conditions and requirements. For such a question, every plant or situation has problems and conditions of its own.



INDUSTRIAL RAILWAY AT MACHINERY PLANT
Narrow-gage train with combined storage battery and trolley locomotive

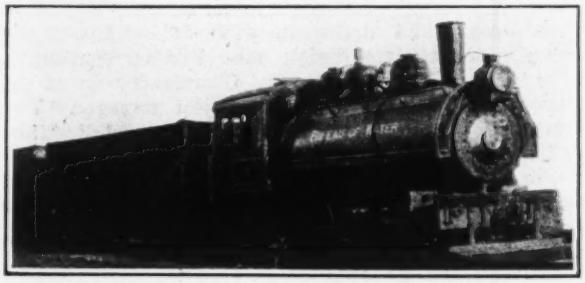
Factors to be considered in deciding upon the track gage suitable for a specific case may include: (1) Comparative cost and convenience of standard- and narrow-gage lines; (2) necessity or advantage of extending standard-gage equipment to various parts of the plant; (3) economy or advantages of using narrow-gage equipment that would not be required to leave the plant; (4) weight, size and character of material to be handled; (5) length of haul; (6) convenience to or obstruction of operations in shops or other buildings; (7) clearance limits as to radius of curves, width of aisles, height to roof, and width and height of doorway openings; (8) tonnage handled daily and number of cars required to handle such tonnage; (9) facilities for transfer between narrow-gage and standard-gage cars, where necessary; (10) type of motive power to be used.

Numerous Narrow Gages

A surprisingly long and varied list of 21 widths of gage for industrial tracks has been developed by inquiry of manufacturing plants and the builders of equipment. Probably this list is far from complete since several builders of equipment report that they have orders for numerous gages "between 16 and 56½ in." The list, as given below, does not include special gages for kiln and oven cars or for transfer cars to shift the plant cars from track to track, as required at certain industries, since such cars are for plant processes rather than for transportation. Only one instance of the meter gage, 39⅜-in., is given, and instances of 60-in. gage for special requirements. The gages are:

In.	In.	In.	In.	In.
12	21½	28	36	44
15	22	28½	39⅜	48
16	24	30	40	56½ (s.g.)
18	26	32	42	60
20				

The 65 miles of 16-in. freight-hauling system of the Chicago Tunnel Co. may be classed as an industrial railway, since its cars run into freight houses, warehouses and wholesale establishments, where they are handled on elevators and floor tracks.



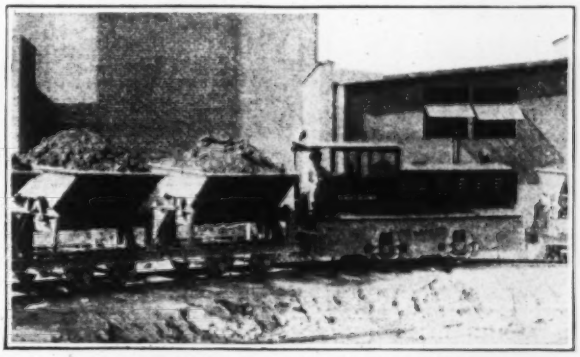
A MUNICIPAL INDUSTRIAL RAILWAY
Standard-gage switching engine

As the various narrow-gage lines are isolated and independent, there might seem at first little object in confining them to a few widths of gage. But it must be remembered that in purchasing material or equipment a

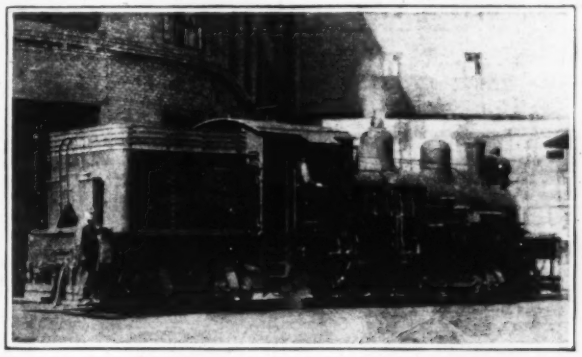
plant having tracks of a special or odd gage may find that its equipment takes longer to procure and costs more than if it could be ordered from stock. This applies also in the purchase of second-hand equipment. Furthermore, some of the gages differ so slightly that there can be no good reason for continuing all of them. Economic advantages to both the manufacturer and the consumer would result, therefore, from some standardization or limitation of track gages.

Standard- and Narrow-Gage Compared

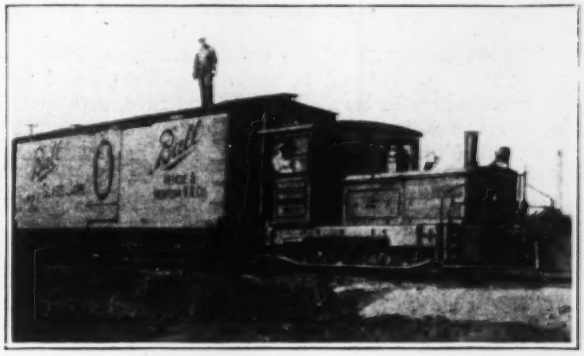
Standard-Gage Industrial Lines—It is generally advisable to extend the standard-gage tracks into the building of shipping and erecting departments, and also into raw material departments, since it is economical and otherwise advisable to do loading and unloading under cover. This is particularly the case in handling heavy goods by cranes. For some plants only short stub tracks are needed for such purposes, thus avoiding the objections to locomotives operating in the buildings. At plants where large numbers of cars are handled, however, it may be more convenient to extend the tracks through the buildings to departure tracks, thus providing continuous movement instead of the reverse movements necessitated by stub tracks. There is less objection to through tracks where the buildings do not require to be heated. Whether separate buildings should have independent tracks, or whether one or two tracks extending transversely through a group of parallel buildings will serve depends on local conditions.



INDUSTRIAL RAILWAY AT BRICK WORKS
Narrow-gage gasoline locomotive



GEARED ENGINE AT RUBBER FACTORY
Switching on standard-gage tracks with sharp curves



SWITCHING AT GLASS WORKS
Standard-gage 24-ton gasoline engine

If these indoor tracks are depressed to bring the car floors level with the shop floor or platform they render a part of the shop area useless for general purposes and may interfere more or less with shop work and movements. In certain cases these particular objections have been minimized by placing the indoor track at one side of the building. As a rule, the use of shop tracks introduces the problem of effective design and maintenance of weatherproof and easy-moving doors for the large wall openings required.

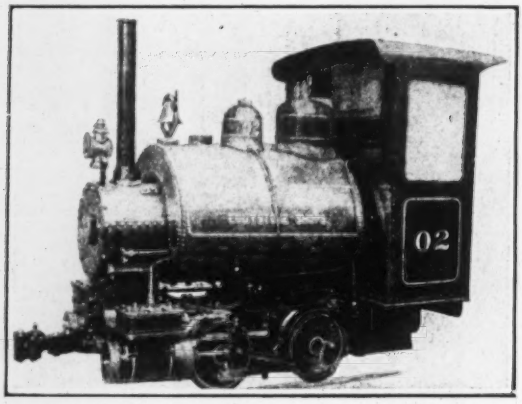
In certain cases, the use of standard-gage tracks through the plant has an important advantage in enabling the plant locomotives to shift the cars. This feature may even facilitate shipments, since at any time empty cars can be placed or spotted as required and loaded cars can be collected and switched to the outgoing track, although the connecting railroad may give switching service only once a day. As a modification of this method, some plants use tractors (not running on rails) to push or haul cars on the plant tracks.

Narrow-Gage Industrial Lines—For light loads and shop service, as well as for special purposes, narrow-gage tracks may be preferable or necessary, as in transporting rolls of paper at a newspaper plant, handling supplies to or in the shops, or handling coal and ash cars at a power plant or charging cars at a steel mill or foundry. Narrow-gage lines at some plants form a comprehensive system to serve inter-department requirements, while at other plants there are merely short isolated stretches of track between certain points.

This discussion is concerned only with railway trackage for plant service, but under some conditions other means of transport may be suitable or preferable. These alternative methods may include tractors, trailers, motor trucks, overhead monorail carriers, overhead traveling cranes and a variety of forms of conveying apparatus adapted to special requirements. On the other hand, it has been claimed that where the haul is more than 1,200 ft. the narrow-gage track is generally more efficient by reason of the smaller amount of power required and the relatively higher speeds. Of seven engineering concerns which specialize in the design of industrial plants, three say that present practice tends to avoid narrow-gage plant trackage wherever possible, the standard-gage lines being extended where necessary or supplemented by other methods of transportation, as noted above. But they all agree that narrow-gage tracks are necessary in certain kinds of plants.

Location and Curvature—Track layouts and limits of curve radius are troublesome factors in plant railway

design. For the first, various departments may have to be served and it is desirable to provide direct movements or routes. For the latter, limited space and the arrangement of buildings and roadways often necessitate sharp curves with large central angles, sometimes making right-angle turns. This problem is the more difficult with standard-gage layouts, particularly if ordinary railway equipment is to be handled over the entire trackage system. Single cars can be operated on sharp curves, either by a small locomotive, a tractor, a power capstan



SMALL LOCOMOTIVE FOR MACHINERY PLANT
Six-ton engine of 24-in. gage

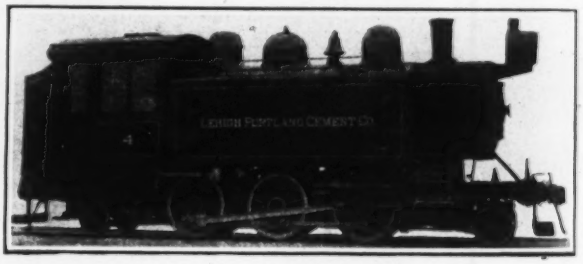
and cable or other special means. But such movements are slow and should not be made necessary if they will cause delay and trouble. With narrow-gage tracks and small cars extremely sharp curves are practicable, or curves may be replaced in some cases by track intersections fitted with turntables. In any case, care should be taken to avoid excessively sharp and numerous curves, as a crooked track layout is sure to result in derailments, delays and other troubles.

For standard-gage track layouts, the minimum curvature for spurs or sidings entering the plant is usually about 24 to 33 deg. (240 to 175 ft.), but railways sometimes prefer to limit this to 21 deg. (275 ft.) or even 16 deg. (358 ft.) for new plants. The long-radius curves, however, occupy so much valuable space and hamper the plant layout to such an extent that a compromise is generally made for curves within the plant. If the industrial concern intends to operate its own switching engines for plant service, so that the main-line engines merely switch cars in and out of the plant, the curves can be more readily adapted to plant conditions. But due regard must be given to the size and length of modern railway equipment, the desirability of free movement, and the desirability of avoiding the trouble, delay and damage involved in derailments. It is stated in the writer's book on "Railway Track and Maintenance" that single cars have been handled on standard-gage curves of 40- and 50-ft. radius, but that in general it is best to have a limit of about 250 ft. (23 deg.) on account of difficulties in operation, high cost of maintenance and the liability of trouble from derailments.

Track Construction—Yard and shop tracks may have relatively light rails laid on wood ties in the usual way, but the ballast is usually inferior in quality and quantity. It should be recognized, however, that if rails and track construction are inadequate for the loads there will be increased cost of maintenance and renewal, greater difficulty in operating and a tendency to derailments which may be costly in actual expense and in interference with plant work or with shipments. For light haulage and with manual or animal traction, 12- and 16-lb. rails are sometimes used, but 20-lb. is generally considered the minimum for locomotive traction, even for lines of 24-in. gage. With 36-in. gage, rails of 45-lb. and upward are used. Some quarries report 60-lb. rails, while industrial tracks at steel works sometimes have 80-lb. rails to insure a good running surface and economy in maintenance. With standard-gage tracks, the weight of rail ranges from 50 lb. upward. The weight and size of loads to be hauled regulate to a considerable extent the capacity of car, and consequently the width of gage and weight of rail.

In shops and yard driveways, the track may be filled with earth, gravel or cinders nearly to the level of the rail head, so that the rails will not form obstructions for workmen or trucks. Where the shop has a paved floor the tracks may be embedded in the paving; this practice requires the preparation of a firm subgrade to prevent settlement and distortion of the floor and track. For standard-gage spurs and sidings operated by the connecting railway, the track and switches should be of substantial construction and maintained in good condition.

Much of the narrow-gage track of 18- and 24-in. gage is made up in portable sections, usually 15 ft. long, with the rails shop-riveted or field-bolted to steel ties of shallow trough or corrugated plate design. These sections include straight and curved track, switches, turnouts and track intersections. This type of portable track is used extensively on construction work, where the railway is a temporary installation. In such cases the 24-in. gage is almost universal. Similar track with gages of 18, 24 and 30 in. is used also in shops, mills



LARGE INDUSTRIAL LOCOMOTIVE
Standard-gage 60-ton engine at cement plant

and other buildings, and is often embedded in a concrete floor, the rail heads being flush with or slightly above the floor surface and flangeways being formed in the concrete. For paved tracks of this sort, the shallow steel ties may be short, projecting but little beyond the rail base.

Locomotives and Cars—Reports from a score of builders of material and equipment for industrial railways indicate a wide difference in the gages for which these products are ordered, but in their opinions they appear to agree largely upon 36 in. as the gage most generally used for plant railways, and 24 and 36 in. for construction or contract work. Gages narrower than 36 in. in manufacturing plants appear to be used principally where made necessary by restricted space between buildings or where made desirable by shop or manufacturing conditions requiring only small and light cars.

Eight companies give 24 and 36 in. as the most usual

gages, four of these mentioning 30 in. as used to a less extent and three mentioning 56½ in. (standard gage) as used where heavy hauling is to be done. Two companies mention 36-in. and 56½-in. as most usual; two give 36- and 42-in.; one gives 36-in. only, and others list 18, 24, 30, 36, 42, 44, 48 and 56½ in., while one goes as high as 60 in. A builder of electric industrial locomotives states that of 300 engines shipped recently, 17 per cent were of 44-in. gage; 14 of 42-in.; 9 of 36-in.; 12 of 24-in.; 8 of 30-in.; 7 of 18-in.; 6 of 48-in.; 3 of 40-in. and 7 per cent of standard gage.

No less than five of these concerns remark upon a tendency to increased use of 56½-in. gage for plant railways, particularly where heavy loads are handled. This applies not only for plants in which ordinary railway cars are operated, but also to those where only plant or service cars will be used. One company has supplied locomotives of 39⅜-in. (meter gage), and believes that there is only one plant in the United States having industrial tracks of this gage, but why this unusual gage was adopted is not known. As to the sharp curves incident to narrow-gage industrial trackage, one locomotive builder states that a four-wheel engine can

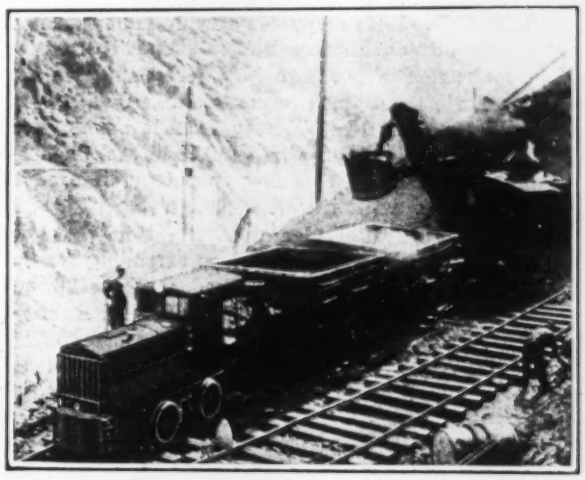
FIRELESS STEAM SWITCHING LOCOMOTIVE
Standard-gage 45-ton engine for salt works

readily pass curves whose radius in feet is equal to the length of wheelbase in inches, while such an engine can operate fairly well on curves of half this radius.

For power traction, steam, gasoline, electric, gasoline-electric and oil-electric locomotives are used. Electric locomotives are largely of the storage battery type on account of the troubles, expense and danger incident to overhead or third-rail conductors, although such conductors are used at a number of plants. Where it is inconvenient to take a storage-battery engine out of service for charging, a small gasoline or oil engine unit may be mounted on the locomotive to maintain the charge in the batteries.

Builders of cars for industrial railway service mainly advocate either 24- or 36-in. gage, depending upon the size of cars required and the loads to be handled. Shortly after the World War a number of these firms united in organizing the Industrial Car Manufacturers Association (since disbanded), one activity of which was an attempt to standardize the two gages mentioned and to eliminate the numerous special or odd widths of gage. The American Mining Institute has recommended 42 in. as standard, with the provision that any other gages should vary by increments of 6 in. But out of six builders of mine locomotives, five say that the gages range from 18 to 56½ in., while one of these also includes 60 in. The sixth says that 36- and 42-in. are the gages principally supplied, while one of the others says 42 and 44 in.

Where V-shaped or rocker side-dump cars are used, 1½-yd. capacity is considered the economic limit for 24-in. gage, as greater size and capacity results in top-heavy conditions when dumping. Thus with a 1½-yd. car, in dumped position, its center of gravity is about over the rail of 24-in. track, while with a larger body the center of gravity would be outside the rail, so that the car would have a tendency to tip over and go off the track when being dumped. In fact, if the material



GASOLINE ENGINE ON CONSTRUCTION WORK
Handling excavation on a large dam in California

being handled is sticky or does not dump freely, the 36-in. gage might be preferable even with 1½-yd. cars of the type noted.

Somewhat similar conditions apply to the width of flat or platform cars. A car floor 36 to 42 in. wide will overhang the gage line by 6 to 9 in. This overhang is considered the maximum ordinarily permissible, especially if the cars are to be loaded from the side, resulting in a tendency of the car to tip when heavy loads are slid over the edge of the floor. Where the commodities to be handled require a car floor 4 to 5 ft. wide, the 36-in. gage is generally preferable. The length of wheelbase of cars should be at least equal to width of gage and preferably greater than this.

For a printing office handling large rolls of paper, a track of 18-in. gage may be sufficient and convenient. In a boiler room or foundry, a 24-in. gage may be suitable for coal cars, charging cars and ash cars, while a machine shop may find 24- or 30-in. gage convenient for handling supplies and small materials. A plate mill, however, may have to provide for handling steel plates 8 ft. square, while a lumber yard, bar mill or pipe mill may have to consider the handling of material in lengths of 20 to 40 ft. For shop and boiler-room service, pushing cars by hand may be neces ary, so that cars must be small and light. A list of equipment suitable for different gages of industrial tracks is suggested by one company as follows:

	Gage 18-in.	Gage 24-in.	Gage 36-in.	Gage 48-in.
Curve radius, min.	8 ft.	15 ft.	30 ft.	50 ft.
Car width	3 ft.	4 ft.	5 ft.	6½ ft.
Car length	4 ft.	6 ft.	8 ft.	10 ft.
Car capacity	1 ton	3 tons	5 tons	10 tons

[*Note—A second article, to be published shortly, will deal with industrial railway installations at manufacturing plants of various kinds and on different classes of engineering construction works.*—EDITOR.]

Difficulties Which Face Jersey Transit Plan Considered

North Jersey Transit Commission Reports on the Legal and Financial Difficulties in Obtaining Transit Relief

CONTINUING the study for a rapid transit system to facilitate intercommunication between the suburban section of northern New Jersey and the city of New York, as outlined in considerable detail in its report of 1926, the North Jersey Transit Commission, in its report of 1927, goes into the legal and financial details which must be overcome in putting into effect its plans for increased transit facilities.

Briefly, the physical plan as outlined in the 1926 report consists of an interstate loop extending from a proposed transfer station on the Meadows above Newark Bay down through Jersey City to the Central Railroad of New Jersey terminal, from where it crosses under the Hudson River to the lower end of Manhattan Island. Continuing up through Manhattan Island to 57th St., it turns west across the Island and under the Hudson River and the Palisades to the Meadows where it turns south again to the Meadows Transfer. It is proposed that this loop will pick up passengers from the several railroads in New Jersey at the Meadows and other transfer stations for movement to New York. The portion of the loop on Manhattan Island is to be either a new subway or by connection with the local tracks of existing subways which now end at the Battery. Within the interstate loop, the plan considers additional cross-river connections through extension of the 14th St. and 41st St. crosstown subways to connection with the loop in New Jersey; also it contemplates ultimately further extension in New Jersey. The plan was described in considerable detail in our issue of Feb. 4, 1926, p. 205.

Few modifications are made in the physical plan as originally proposed except that, at the request of the Port of New York Authority, a study was made to determine the advisability of making provisions for rapid transit on the proposed Fort Lee bridge, and, at the request of the city government, for possible connections with the independent subway system now under construction by the Board of Transportation in New York. However, one modification is suggested due to the present controversy regarding the subway policy in New York City. It is a proposal that negotiations be undertaken with the Westchester County Transit Commission looking toward the extension of the proposed subway of that commission from its terminal in lower Manhattan under the Hudson River to the Jersey Central terminal and then over the Newark branch of the Jersey Central to Broad St. station in Newark, and from the Jersey Central station as far as the proposed Meadows Transfer.

In a study of the financial features of the plan prepared for the commission by Philip H. Cornick, specialist in taxes and assessments, it is recommended that the proposed system be publicly financed and publicly owned, that bonds be issued for construction cost supported by supplementary pledges of the full faith and credit based on the taxing power, and that the maximum term of all bonds issued be fixed at 35 years. As the result of Mr. Cornick's study, he finds that two statutory changes are desirable in New Jersey in order to put the plan into effect, namely, one, that municipalities be given the right to finance the transit lines, which they are already authorized to build, by levying all or part of the cost of construction on land in the vicinity benefited thereby; and two, that transit districts be created with powers to levy special assessments for benefits.

On the subject of assessing part of the cost of construction against property in the areas to be benefited by the proposed transit system, Mr. Cornick states that the total number of individual parcels of land in the North Jersey transit district probably would run over a million, of which half at least would be classed as benefiting from the transit facilities, and that while the preparation of assessment roll is practical in small areas, such as individual municipalities, the preparation of an assessment roll for the whole district would be so complicated as to be impractical. Consequently, he proposes that the spreading of the assessment be made in two steps. In the first, the district would apportion the special assessments among the municipalities in the area on the basis of the amount of benefit they would receive from the new facilities; and in the second step the individual municipalities would spread their share over the land under their jurisdiction. This operation would place the work of preparing assessment rolls in the hands of municipal officials already in such work.

The difficulties which face the organization of a district capable of financing and building the proposed transit system and some recommendations as to how they are to be overcome are given in a section of the report prepared by Spaulding Frazer, counsel for the commission.

The review of the various methods used throughout the country for carrying out construction work by the organization of special assessment districts and by the assessment of benefit levies against property, given in this report, constitutes a valuable record of such procedure.

Iron Roofing Sheet Carried 50 Miles in Tornado

According to a brief report in *Monthly Weather Review* of November on the tornado that destroyed a school house at La Plata, Md., on Nov. 9, 1926 (*Engineering News-Record*, Nov. 18, p. 832), a piece of galvanized iron roofing 8 ft. by 2 ft., coming from La Plata, fell in a farm yard 6½ miles from Annapolis, or about 50 miles from La Plata. Parts of desks from the La Plata school, it is also stated, were found 7 miles away from the site. The report, by Thomas R. Brooks of the Forecast Division of the U. S. Weather Bureau, says that trees, debris and houses on either side of the tornado path were mostly blown inward toward the center of the tornado, but also forward, making an angle with the path; trees and houses near or in the center of the path were carried straight forward, while a few trees at the edges were blown at right angles across the path. However, the school-house wreckage and trees surrounding it were blown slightly toward the direction from which the storm approached. The storm track was traced for 15 miles—which it is believed was covered in 20 to 25 min.—from La Plata to a little distance beyond Cedarville, beyond which point it apparently dissipated. It is also stated that at some places the tornado passed completely over the tops of trees, and at other places it furrowed into the soil. Many fallen trees showed signs of having been twisted off, and some tree tops were definitely twisted in anti-clockwise direction.

Four-Lane Flexible Paving Slab for Concrete Streets

All Joints Doweled But No Reinforcement Was Employed—Subdivision of Slab Depended on to Eliminate Cracking

By F. M. Balsley

Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

A NEW concrete pavement section for city and village streets that is novel in that no reinforcing steel is required regardless of the width of the street, is being built in Wisconsin. This pavement is built one-half at a time, using steel or wooden forms on the center line. A parting strip ¼ in. narrower than the depth of the slab is installed at the quarter points. This parting strip is staked in place and held in a straight line by an installing bar during the pouring of the concrete. Dowel bars of ½-in. deformed steel, 4 ft. long, hold the sections together and distribute the loads. At the form face the dowel bars are bent to 90 deg., and after the concrete is spaded the bars are pushed into the slab with one leg against the form face. Paraffin pasteboard ¾-in. tubes are used to cover the bar at the form face to facilitate removal. After the first section has taken set, the dowel bars at the center are straightened out and the second section is placed. In striking off the second section a ¼-in. strip of metal should be placed under the strike-board where it rests on the slab already in place to allow for the shrinkage of the concrete in setting.

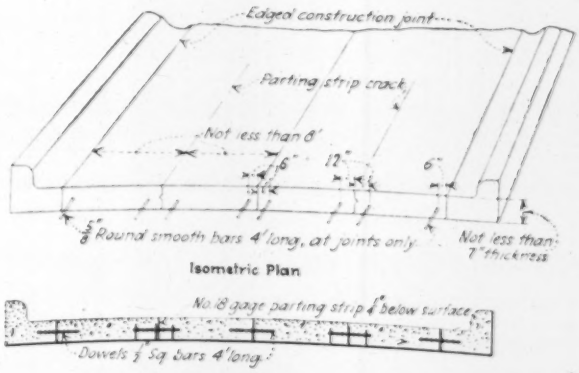


FIG. 1—FLEXIBLE FOUR-LANE CONCRETE PAVEMENT STRUCTURE

A feature of this design which should appeal to engineers is its flexibility. Subgrade disturbances, whether upheaval or settlement, will not crack the slabs except in extreme cases. No reinforcing steel is needed except over recently filled trenches. The saving in this one item will amount to at least 10c. per square yard on work of this character. Finally, the maintenance of the cracks above the parting strips and the center joint still divide the street into four parallel lanes. This will tend to separate and keep vehicles in the proper lanes of travel as well as promote parallel parking where parking is permitted.

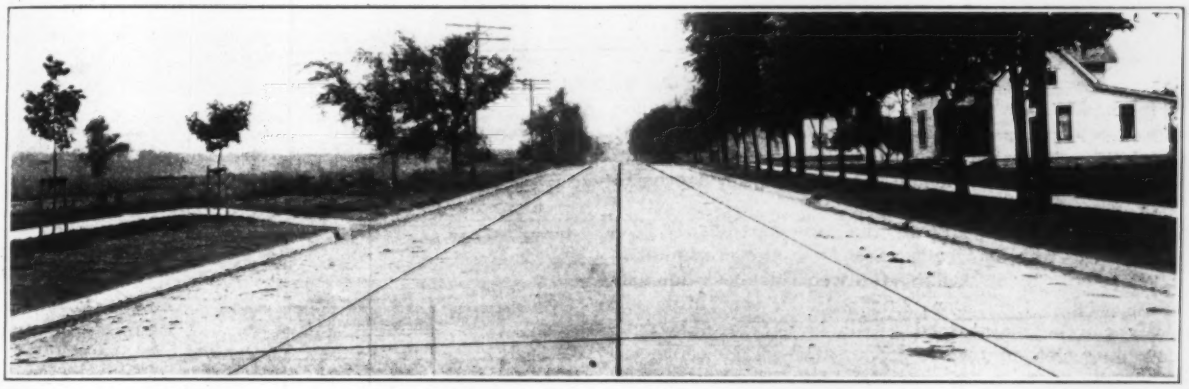


FIG. 2—COMPLETED FOUR-LANE PAVEMENT IN RACINE, WIS.

Transverse expansion joints are placed at intervals not to exceed 35 ft. and the slabs are doweled together with ¾-in. by 4-ft. smooth round rods, using two dowels to each section. The slip ends of these dowels are covered with pasteboard or tin tubes of sufficient length to provide a recess at least 1 in. deep beyond the tip of the bar to provide for movement when extreme slab expansion takes place.

Paving the street one-half at a time makes it possible to use a strike-board that can be easily handled by two men, whereas if the street is built in one operation it is often necessary to finish to stakes, which does not provide nearly as good riding as where the surface is struck off.

Indianapolis Flood Potection

In continuation of the flood protection work along the White River at Indianapolis, Ind., as reviewed in *Engineering News-Record*, Aug. 6, 1925, p. 213, the city proposes this year to deepen and straighten the channel between Raymond St. and Morris St., a distance of about a mile. The dredged material, about 1,283,500 cu.yd., will be placed to form an embankment or levee, with a roadway along the top and with the slope protected by stone riprapping. In addition a five-span bridge will be built at Morris St. The bridge is estimated to cost $454,000 and the other work $685,000. This improvement will be carried out under the direction of C. C. Oberleas, city civil engineer, with H. W. Cassady, assistant engineer, in direct charge.

New I-Beam and Column Sections Produced by Carnegie

Wide-Flange Shapes 8 to 30 Inches Deep Rolled on New Mill Include Constant-Depth Series —Flange Faces Parallel

A RADICALLY new series of beam and column sections is announced by the Carnegie Steel Co. The new shapes, which are of the wide-flange form, are rolled on a mill of wholly new type, recently put in operation at the company's Homestead works. Commercial rolling of a number of the sections began early in January; rolls for the remaining sections are being completed.

Ranging from 8 to 30 in. in depth, from 6 to 16 in. in width, and from 21 to 305 lb. per lin.ft. in weight, the new sections are distinguished by certain noteworthy features in addition to their great range in weight and the fact that previous maximum weights of section available are exceeded by some 16 lb. Most prominent is the fact that the sections have no internal flange slope, all the flanges being of uniform thickness throughout their width. Several constant-depth groups and several uniform-width groups of sections are included in the series, for convenience and economy in column and girder service respectively. The progression of depths has been adjusted to give more economical selection of beams than was possible with previous series; especially interesting is the elimination of the 15-in. I-beam and the substitution of 14 and 16-in. depths in its place.

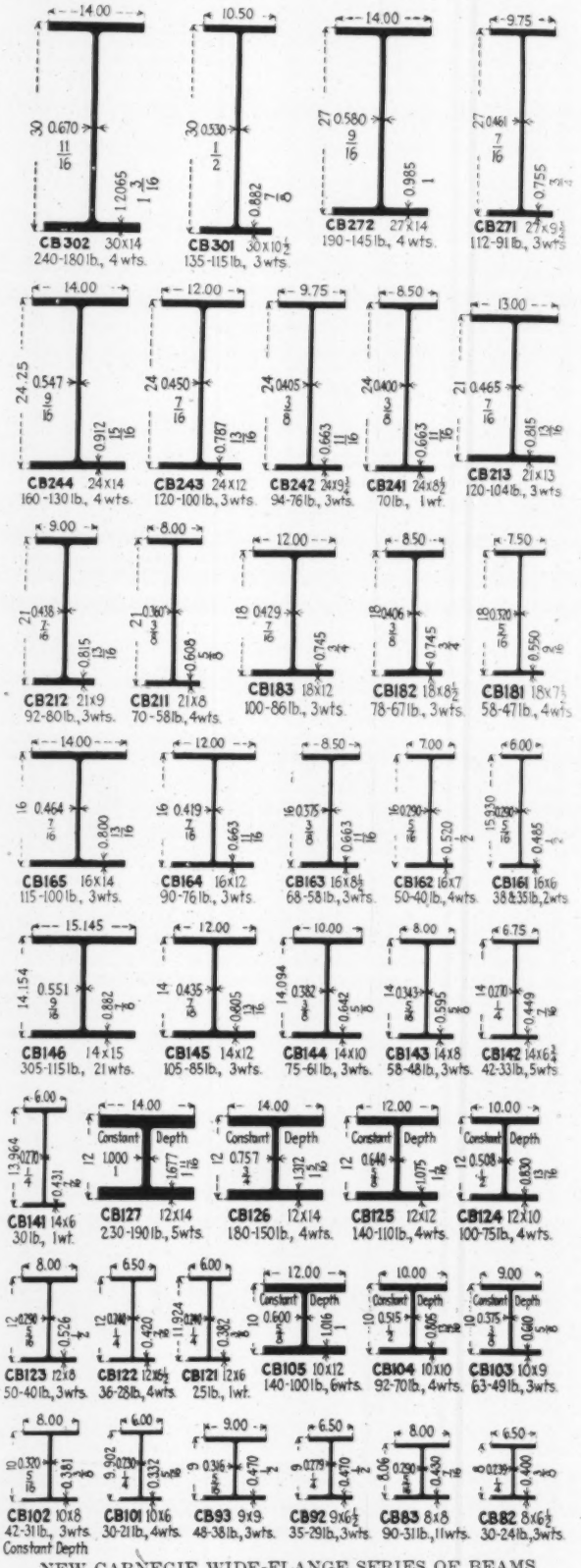
An important feature of the new sections is that varying the weight of a section from the minimum is done not only by increasing the web thickness but also by increasing the flange thickness, so that high efficiency can be maintained. This is not feasible with the rolling method used to produce the sections hitherto standard, but is readily practicable with the working method of the new mill. The only exceptions are the constant-depth column sections, where change of flange thickness would change the depth of the section.

Forty-one sections, which with variations of thickness give 161 separate weights, are included in the series. Their design throughout has been studied with a view to both efficiency of structural service and ease of fabrication. The new series of sections is fully described by the company in a statement whose most interesting parts are reproduced in the following:

Contour—In general contour, all sections, whether for beam or column service, have flanges of uniform thickness throughout their width. This feature increases the strength of the section (by disposing most of the metal as far as possible from the neutral axis), permits simple connections, and facilitates fabrication. It also makes possible the interchangeable use of sections, for example as either beams or columns, and thereby reduces the variety of sizes that need be carried in stock, permits a quicker cycle of rolling, and allows a large degree of standardization in shop methods and tools.

Range of Depths—The range of depths covered by the new series discloses a daring innovation, namely omission of the 15-in. beam, hitherto the most widely used size. The significance of this change may be appreciated from a brief review of American beam practice as to depths.

Forty years ago the largest metal beam section rolled was 15 in. deep, this size having supplemented the previous 12-in. maximum not because it was part of a consistent series but because new mills had been built that could produce a 15-in. beam. In 1889, a yet larger mill was built, capable of producing beams 20 in. deep, and this size was added to the list, again not because it belonged in an orderly sequence but because it was the largest size then producible. Soon after 1890 a 24-in. size was added for similar reasons, and an 18-in. section was interpolated be-



NEW CARNEGIE WIDE-FLANGE SERIES OF BEAMS AND COLUMNS

Rolled in 41 sizes, 8 to 30 in. deep, in various weights up to 300 lb. per lin.ft. giving a total of 161 sections. The diagram shows the minimum-weight section of each size.

tween the 15 and 20-in. sizes. In 1896 standardization was reached with regard to beam sections, the American standards, 8-in. and larger, then comprising 8, 9, 10, 12, 15, 18, 20 and 24-in. sections. About 1908 a new type of mill made possible the production of still deeper beams, and 26, 28 and 30-in. sizes were offered, together with an interpolated 22-in. depth. Shortly thereafter sections 21 and 27 in. deep were produced. Finally, last year the range below 12 in. was amplified by a series of very light sections for joist-beam use.

Thus we find the ranges below 12 in. and above 18 in. fully covered by a profuse variety of depths, stepping by not over 2 in.—this discussion does not relate to sections rolled for use as columns—but strangely enough the important range between 12 and 18 in., in which occurs the greatest normal tonnage demand, was left with only one intermediate beam depth, 15 in.

Rectification of the anomaly in progression of depths has finally been accomplished in the new series, by omitting the time-honored 15-in. beam and offering in its place 14 and 16-in. sections to fill the gap in the popular range between 12 and 18 in. more efficiently. Sections nominally 14 in. deep have been previously rolled for column and heavy girder purposes, but the new series makes this depth available with dimensions suited also for use as minimum-weight beams. The 16-in. depth has not previously been rolled in America for any purpose.

The new series approximates a progression in which each depth is 15 per cent greater than the preceding. This permits a consistent series of thicknesses and weights so arranged that the section strengths also have approximately regular ratios of increase.

In addition to its purely engineering features, the new series is not neglectful of adaptability to architectural considerations. Thus, it includes intermediate groups of sections, wider, heavier and stronger than the minimum for each depth, that will be found suitable for use as beams where limitation of depth or maintenance of flush ceilings is the important feature. Uniformity in fireproofing and finish is also enhanced, for example, by the use of minimum weights of the 10, 12, 14 and 16-in. sections, which in the new series have a uniform width of 6 in.

Railroad engineers will doubtless be especially interested in the provision of efficient sections, notably 12 in. and deeper, containing no metal thinner than $\frac{7}{16}$ in., and it seems probable that the complete groups of 24, 27 and 30-in. sections, with flanges 14 in. wide, may find useful application in grade-crossing eliminations and similar structures where limited clearance is controlling. The substantial width of these sections makes them suitable also for use in structures that it is inconvenient to brace laterally.

Column Sections—Turning to column design, two novel features characterize the new series, namely, excess of width over depth, and constant depth. It has hitherto been the practice to make H-column sections square at their minimum weights, that is, with the same depth and width. The new series contains column groups whose minimum-weight sections are considerably wider than their depth. Thus there are groups 10x12 (10 in. deep and 12 in. wide), 12x14 and 14x15. This innovation results in great strength about the critical minor axis, combined with a minimum diameter of fireproofing and finish, and thereby provides a maximum of light, ventilation, and usable floor space, which are especially desirable in tier-buildings.

Groups of column sections having constant depth are not entirely new to the structural industry. A few years ago the American Bridge Co. designed a series of fabricated plate-and-angle columns with constant dimensions, which soon became popular. Now, however, several groups of sections are made available which combine the advantage of constant depth with the economy of a rolled as compared with a built-up section. Constant-depth column sections permit obtaining a degree of symmetry in beam, girder, and spandrel framework that is favorable to the use of multiple production methods, resulting in substantial savings in drafting room, fabricating shop and erection. The simplification of details on the columns themselves, including the avoidance of fillers under the splices, is also advantageous. To the architect and the general contractor constant depth is valuable because of greater uniformity in fireproofing and finish.

Sections of constant depth type are offered in two depths, 10 and 12 in. The 10-in. group, 31 to 140 lb., can take care of an ordinary 12-story building from basement to roof; together with the 12-in. group, 75 to 230 lb., it will take care of an 18-story building.

Integral Weights—All section weights are expressed in whole pounds, thus avoiding the annoyance of fractions. The heavier column weights in the 12-in. groups end in zero, and stagger with those in the 14-in. groups, which end in five, thus enabling a designer to change sizes with a minimum waste of metal.

Index Numbers—A safeguard against error in the transmission of orders is provided by a system of section index numbers whose penultimate figures represent nominal depth in inches. Thus, section CB 301 is 30 in. deep, while section CB 82 is 8 in. deep.

A handbook has just been published by the company showing the profiles and properties of the new sections, arranged for application under any building code or specification and giving detail information about them. Separate handbooks giving load capacities based on important special specifications will also be issued.

It is understood that the standard sections rolled up to the present will continue to be rolled as long as they are in demand.

Quantity Surveying and Surveyors

AN explanation of the purposes of a quantity survey and the duties of a quantity surveyor, the following extract is taken from a paper on "Economics Applied to the Construction Industry" by G. Szmak, Bridgeport, Conn., secretary of the American Institute of Quantity Surveyors.

The branch of engineering which deals with the quality and quantity of matter used in the erection of architectural and engineering structures is known as construction surveying, sometimes called quantity surveying among the profession and in some countries where it is practiced under that title. This branch of engineering is fast gaining in importance due to its high economic value. Construction surveying is the science of measurement and tabulation applied to the physical members of a structure, expressed in uniform units of measurement, with an analysis and detailed accounting of its requisite quality and quantity of material and labor applications.

Persons engaged in the construction surveying profession are known as construction and building surveyors, or quantity surveyors. The profession is purely one of economics, the elimination of waste in the process of constructing architectural and engineering structures. It is not within the scope of the profession to design or erect a structure, these functions being handled by the architect and constructor. An experienced quantity surveyor can furnish information of great economic value to the architect or his client in the efficient selection of materials and labor because he not only keeps posted on their relative costs but also has knowledge of what method in design of any given material will prove most economical to construct.

Construction surveys can be used on lump-sum, cost-plus-percentage, unit price or any other form of contract. The survey will in any case perform its economic function. The cost of designing a structure is usually from 3 to 10 per cent of its physical value and the fee for construction surveying is about 25 per cent of the cost of designing. The amount paid to the surveyor is saved several times over through the elimination of waste. The quantity surveyor's fee may be paid direct by the owner, incorporated within the fees of the architect, or included within the contract of the successful constructor. The surveyor may be employed direct by the owner or his representative, the architect or designer. The process of having a construction or quantity survey prepared is simply to secure the services of a surveyor upon the completion of the plans and specifications, prior to securing bids from the constructors or builders. The survey is furnished to the bidders along with the plans and specifications, giving them a definite instrument of purchase, a complete plan with specific instructions, and a survey expressing full intentions of purchase in regard to structural dimensions, physical members in detail, and the quality and quantity of materials and workmanship.

Building a Difficult Mat Foundation at 53-Ft. Depth in Cleveland Sand and Clay

Ohio Bell Telephone Building Founded on Concrete Mat on Clay—Sand Layer Drained During Construction to Prevent Uplift—Side Walls Built in Trenches—Building Frame Constitutes Final Bracing

By Richard P. Wallis
The Lundoff-Bicknell Co., General Contractors, Cleveland, Ohio

FIG. 1—OHIO BELL TELEPHONE BUILDING

SOIL conditions, the desire to develop basement space by a deep substructure, and the presence of buildings with shallow foundations on either side of the site controlled the foundation construction for the new 23-story office building of the Ohio Bell Telephone Co. in downtown Cleveland, and led to the adoption of most interesting methods both in planning and execution. The superstructure of this building will, when completed, tower 360 ft. above the pavement and will occupy a ground area 154 ft. 6 in. x 142 ft. 10 in. There will be three basement floors, the lowest 42½ ft. below grade. The sub-soil consisted of sand overlying a fine, fairly hard gray clay, as elsewhere in Cleveland; groundwater level is some 25 ft. above the top of the clay. Practice in Cleveland has uniformly been to support the loads of buildings on the sand above the clay, as the water-bearing sand would present considerable difficulty in cofferdamming down to the clay. In the present instance, however, it was thought best to carry the foundation down to the clay both to gain basement space and to obtain a foundation secure against the risk of settlement by future disturbance or drainage of the sand. The development of the plans on this basis and the execution of the work against a number of complicating conditions constitute the interesting elements of the undertaking.

Physical Conditions—East of the site and separated therefrom by a 12-ft. alley stands the Caxton building, an 8-story brick structure with foundation about 13 ft. below grade. On the opposite side the Goodman building, a 5-story brick structure with foundation only 6 ft. below sidewalk level, directly adjoins the west building line. These foundations were 40 to 45 ft. above the level of the proposed telephone building foundations.

The clay deposit, at 53-ft. depth below surface, afforded an ideal medium of support for heavy loads if distributed by a properly designed mat. The unit pressure which the building would bring to bear on the soil was well within the safe bearing power of the material, both at the center, where both the loading and bearing power of the soil would be greatest, and toward the perimeter of the site, where the bearing power would be less. However, about 8 ft. below the top of the clay a stratum of water-bearing sand under full hydrostatic head was disclosed by the borings. This same deposit is found in other building areas nearby and its presence is said to have deterred other engineers from carrying foundations down to the clay, on account of the danger of the clay blowing up under the hydrostatic pressure in the sand below. However, it was hardly practicable to go through the water-bearing sand layer with the mat excavation, on account of the expense and difficulty and the fact that the additional cellar space produced would have little value.

The danger of developing uplift from the underlying sand stratum was removed by driving 6-in. steel pipes through the sand and about 1 ft. into the underlying clay as drains. When driven, these pipes were cleaned out with an auger bit and filled with a medium gravel, and then pulled up so the bottom of the pipe was 2 or 3 ft. above the sand, the pipe then forming a drainage well. These wells relieved the hydrostatic pressure in the sand, water flowing upward through the gravel filling without carrying sand out of the stratum. As the excavation proceeded downward, the pipes were burned off and the sand thus continuously drained until the mat had been poured, the columns erected, and sufficient dead-load placed to overbalance the uplift; thereafter they were plugged with concrete. It should be said that after the first few days the flow from these drainage wells was very small, and during most of the construction there was only a seepage of water through each.

Type of Substructure—Briefly described, the substructure as planned and constructed may be said to consist of a 5-ft. concrete mat reinforced top and bottom with bands of 1-in. reinforcing rods, by which the column and wall loads are distributed to the underlying soil; and side walls 2½ ft. to 3 ft. 4 in. thick in their lower portions.

The use of this concrete mat covering the entire area was dictated by the character of the clay, the material having relatively low supporting value when loaded on small areas, but adequate supporting value on large areas. The side walls were designed to be braced ultimately by the steel and concrete slabs of the finished basement floors; during construction it was, of course, necessary to provide temporary bracing. The method of construction of these walls and the nature of the bracing were controlled largely by the presence of the adjacent buildings.

The walls were built first, before general excavation of the site, within narrow trenches. After they were built and progressively braced as the excavation proceeded downward, the mat was constructed, the steelwork erected upon it (the east and west rows of wall columns are carried on the foundation walls) and the

floor construction put in, permanently bracing the substructure.

To give an understanding of the magnitude of the entire operation, a few of the quantities of material in the foundation may be mentioned. The mat alone comprises 4,550 cu.yd. of concrete, sufficient in itself to form the structural portion of a fair-sized office building. The walls increase this amount to nearly 8,000 cu.yd. There are 244 tons of reinforcing steel in the mat, and 206 tons in the walls, a total of 450 tons. This is about as much reinforcing material as is required for the entire floor construction of a 20-story hotel now being built. The timber bracing necessary for the temporary support of the substructure consumed 388,000 ft. b.m., enough to construct 10 average frame buildings.

Underpinning—Before wall construction began, steam shovels removed the débris of the old Huron Road Hospital and the Empire Theater, formerly occupying the site. At this time a top cut was made to the level of the Caxton Building footings, but on the opposite side, along the Goodman Building, a 20-ft. berm was left. Thereupon the underpinning of the adjacent structures was undertaken, this being necessary because of the depth of the excavation and the questionable character of the shallow footings.

Under the Goodman Building footings, nine evenly spaced pits about 4x6 ft. were dug to water level, 20 ft. below the existing foundations. Pairs of 15-in. pipe piles were driven in 5-ft. sections in each pit, to an elevation slightly below the underside of the future mat. These piles were filled with concrete and were capped with a concrete pier filling the pit to within 2½ ft. of the old wall footing. Two 125-ton hydraulic jacks on each pier took the weight of the wall and transferred it to four lengths of 15-in. I-beams set as columns between pier and wall footing. The jacks were released after these I-beam posts were wedged in place tightly between ½-in. bearing plates.

Underpinning the Caxton Building wall was carried

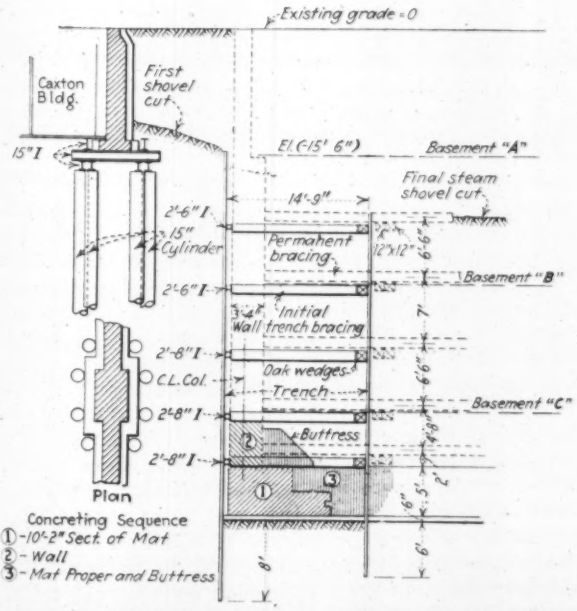
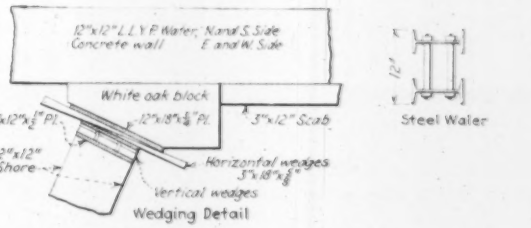


FIG. 2—CAXTON BUILDING UNDERPINNING AND METHOD OF BUILDING CELLAR WALLS IN TRENCHES



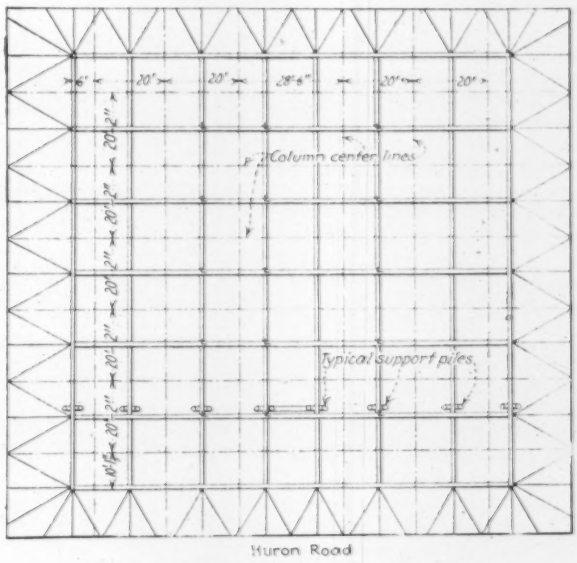


FIG. 3—TYPICAL PLAN OF TEMPORARY CROSS-LOT BRACING

out by a similar method. This foundation consisted of column footings connected by a narrower wall footing. Eight 15-in. steel piles were driven symmetrically about each column footing. Rows of horizontal I-beams were placed on top of these piles parallel to and on either side of the wall, and concreted in. Just sufficient space was left between the top of these beams and the underside of the footing to permit the installation of four short beams at right angles to the wall. A third tier was then placed resting on the ends of these intermediate members, on either side of the wall and parallel to the lower members. These two upper tiers were rigidly connected and hydraulic jacks were introduced resting on the lower beams and supporting the upper. When pressure was applied the effect was to support the wall on the sling formed by the two upper tiers. Wedges were driven between the lower beams and the transverse beams to take up the slack. It is interesting to note that the lifting power of these jacks was sufficient to cause failure of two of the transverse beams. This system of underpinning proved entirely satisfactory and permitted the necessary adjustment to take care of whatever settlement developed during the progress of the operation.

In order to safeguard this underpinning against disturbance by reduction in skin friction due to the telephone building excavation, the hydraulic jacks were kept in place until the permanent supports to the east and west walls of the new building had been provided; any tendency to settlement of the underpinning construction was taken up by the jacks.

Wall Sheeting—As soon as the safety of the adjacent building had been assured, steam shovel excavation was

resumed and a cut made to within a foot or so of water level. Steel sheetpiling 45 to 50 ft. long was next driven around the property line, starting at the southeast corner and going thence along the east wall, part way across the north side, and along the west side close to the Goodman Building line. The row forming the south wall of the steel cofferdam was driven last, to leave a runway for trucks. The sheeting was driven far enough below the bottom of the mat to cut off the flow of water in the sand stratum underlying the clay and very little of this sheeting was subsequently salvaged.

The specification called for constructing the east and west walls in trenches prior to the excavation of the main area. It was therefore necessary to drive an inner row of 38-ft. piling about 15 ft. from the outer row along these two sides. Building the walls within trenches gave an ideal degree of safety, especially at the Caxton Building, which was used by newspaper and printing establishments and showed a distinct vibration on all column footings from the running of the presses. Its footings being at a high level, even the underpinned footings might be in a hazardous condition if held by only a single line of sheetpiling, in view of the vibrating heavy surcharge. This risk was minimized when the excavation was reduced to a relatively narrow trench, thoroughly braced. Trench construction on the west side of the lot was decided on to balance the east wall construction, both in relation to the mat construction and to the cross-lot bracing.

On the other hand, the north and south walls were constructed considerably beyond the column line, and were not endangered by building foundations adjoining. The mat here was designed to project sufficiently beyond the exterior lines of columns to continue the reduction of unit pressure on the clay to the point desired in the design. This was possible on the north side because of the sidewalk-vault construction and on the south side because the telephone property extends to the south, where an addition may later be built. Accordingly it was not necessary to resort to a double line of sheeting.

Owing to the restricted area available for working purposes, the trenching was done with 1-yd. clamshell buckets operated from tractor mounts. Similar clamshell excavation was done later, in taking out the core of the lot between and through the cross-lot bracing, the clamshell bucket in this case being handled by derricks located at the four corners of the site. This method of excavation, which is not common in many other cities, proved remarkably efficient and enabled low costs to be realized.

As the trench excavation progressed, heavy transverse timber bracing was set between the two rows of sheeting, comprising five tiers of horizontal 12x12's, averaging 6 ft. on centers, the bottom tier just clearing the top of the future mat. This bracing bore against steel walers, pairs of 10-in. I-beams, on the outer sheetpile walls and 12x12-in. wood walers on the inner sheeting. It was brought into compression by means of oak wedges and blocks. Steel walers were used at the outer side as they would later be concreted in.

Much difficulty was caused by leaks in the steel piling, apparently due to the fact that the sand, which became progressively finer downward, wedged itself in the sheetpiling joints and occasionally caused a stripping of the joint lock. The leaks were difficult to stop because of the heavy groundwater head, and caused considerable delay. After many costly expedients a semi-cylindrical drum of heavy plate was driven along the wall at each leak, to isolate it. These drums were up to 34 in. in diameter and were securely wedged against the opposite wall of sheeting. Where leakage still continued, lengths of reinforcing rods were driven between the edge of the drum and the wall of sheeting and carefully calked. The drums were for the most part left in place and became a permanent part of the construction, this being permissible due to the fact that the sheeting was sufficiently beyond the minimum back of wall to clear the drums.

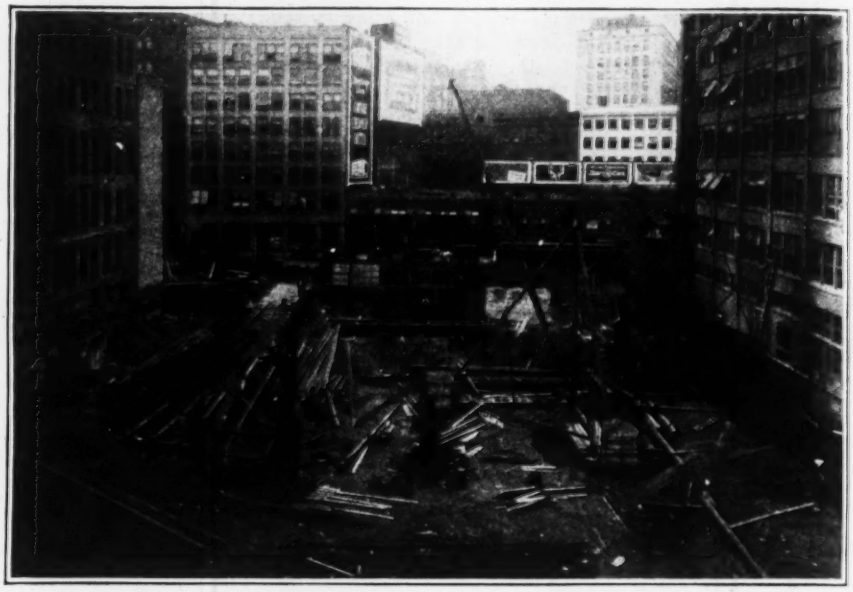


FIG. 4—DRIVING SHEETING FOR EAST WALL TRENCH, OHIO BELL TELEPHONE BUILDING

Realizing that it would be necessary to remove the temporary timber bracing above the concrete mat before constructing the lowest basement floor slab, the design of the substructure provided buttresses at the base of the east and west walls, to permit keeping the wall thickness down by reducing the unsupported height below the lowest remaining tier of timber bracing. Their form is indicated in the sketch Fig. 2, and as shown by the hatching in the sketch the buttresses were poured with the mat. Accordingly, when the wall excavation was completed, the concrete wall footings between the buttresses, a length of 10 ft. 2 in. each, were poured. These sections were left notched in order to afford a good bond with the mat that was to be poured later. Following this, the remainder of the wall up to the highest basement floor was poured, in one operation. In order to leave the trench open for as short a time as possible, the wall was poured in vertical sections as rapidly as completion of the excavation permitted. In

the case of the east wall, only one construction joint was required, while the west wall required three such joints. During the concreting the original trench bracing was not disturbed, but the struts were boxed; later, on removal of the struts, the holes formed by the boxing were carefully filled and waterproofed.

Three one-bag portable concrete mixers were used in the wall concreting. For the lower part of the wall they were located along the top of the trench, but for the upper sections they were at sidewalk level, the concrete in each case being placed by gravity.

General Excavation—Excavation of the core of the building site was begun upon completion of the lower sections of wall. Timber cross-lot bracing from wall to wall was put in as the excavation progressed, arranged as sketched typically in Fig. 3. The full system included five tiers of timbering (Fig. 5). Before commencing excavation, supporting piles were driven in pairs about 16 ft. on centers in both directions, spaced so as to miss both the final vertical posts of the bracing and the future steel columns of the building, and serving to support the timber bracing in collaboration with a full system of vertical trussing. The upper tier of bracing was laid directly on the ground, the north-south members resting on sills bolted to the piles and they in turn carrying the east-west timbers. The struts forming the outer panel of bracing rested against the concrete at east and west walls, but along the north and south walls bore against walers placed along the exposed sheetpiling. Beveled white oak heel blocks, sketched in Fig. 3, took the thrust of the struts through double (vertical and horizontal) sets of wedges between steel bearing plates. Other sets of double wedges were inserted in the struts themselves. It is interesting to note that it took four days' driving of wedges to bring the timbers to their ultimate compression. The struts were cut square at the mill, but in order to secure better bearing they were butted together in the field and a saw cut made between them, but they were compressed 2 in. in the width of the lot before assuming full load.

As already noted, excavation of the core of the site was accomplished by means of four clamshell buckets handled by derricks at the four corners of the lot. The earth in the central part of the site was removed ahead of that in the outer parts of the area, with the result that natural drainage toward the center facilitated the removal of surface water. Timbering operations followed the same sequence, so that at all times the bracing in the center was one tier ahead of that near the walls.

Concreting of the foundation mat was started as rapidly as possible following the completion of the excavation. Provision had been made for stopping the pouring at certain predetermined points should this be necessary, but fortunately all went well and the operation was completed in one pouring, beginning at 2:30 Wednesday and ending at 11:30 p.m. Friday, 57 hours. For the most part the concrete was spouted directly from a mixer located on the bank. After the mat was completed the lowest tier of bracing was removed.

The top surface of the mat was pitched to drain to nine symmetrical outlets, providing for washing the mat floor, and permanent drain lines were concreted in the mat.

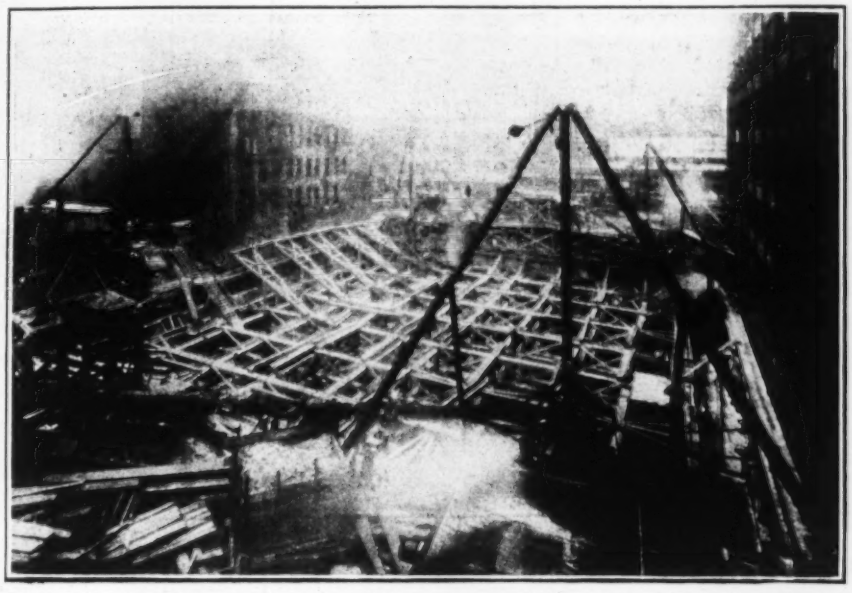


FIG. 5—EXCAVATION AND BRACING OF LOT AFTER SIDE WALLS WERE BUILT

The north and south walls were subsequently poured to their full height. The upper parts of the concrete walls on east and west sides were poured as soon as the grillages and wall columns in the line of these walls were set in place.

As rapidly as possible, after the completion of the mat, the steel columns and floors were erected, and the floor slabs concreted, to provide the permanent structure to brace the walls of the area in place of the temporary timber bracing. The third and fourth tiers of timber bracings were taken out when the lowest basement floor had been poured and the steel of the next basement floor had been set and wedged. Similarly, the upper two tiers were removed when the next basement alsb and upper basement floor steel were in place.

The transverse girders of the floor framing do not bear on the concrete wall directly, but against horizontal steel girders placed along the walls. This arrangement was necessary because the outer bays of the floors contain cable slots, vent ducts and other openings, so that the floor slab itself could not be depended upon to resist the inward pressure of the walls. The steel girders which deliver the wall pressure to the struts offered a means of wedging between the girders and walls so as to deflect the girders initially and to stress the struts, thus permitting a transfer of the wall load from the temporary timber bracing to the steel bracing without any movement of the walls. This forestalled the possibility of cracking of the walls and the further contingency of settling of adjoining buildings upon the removal of the timber bracing system.

This foundation work was carried out by the Lundoff-Bicknell Co., general contractors, under the direction of the Hubbell & Benes Co., architects, and Moran, Maurice & Proctor, consulting engineers.

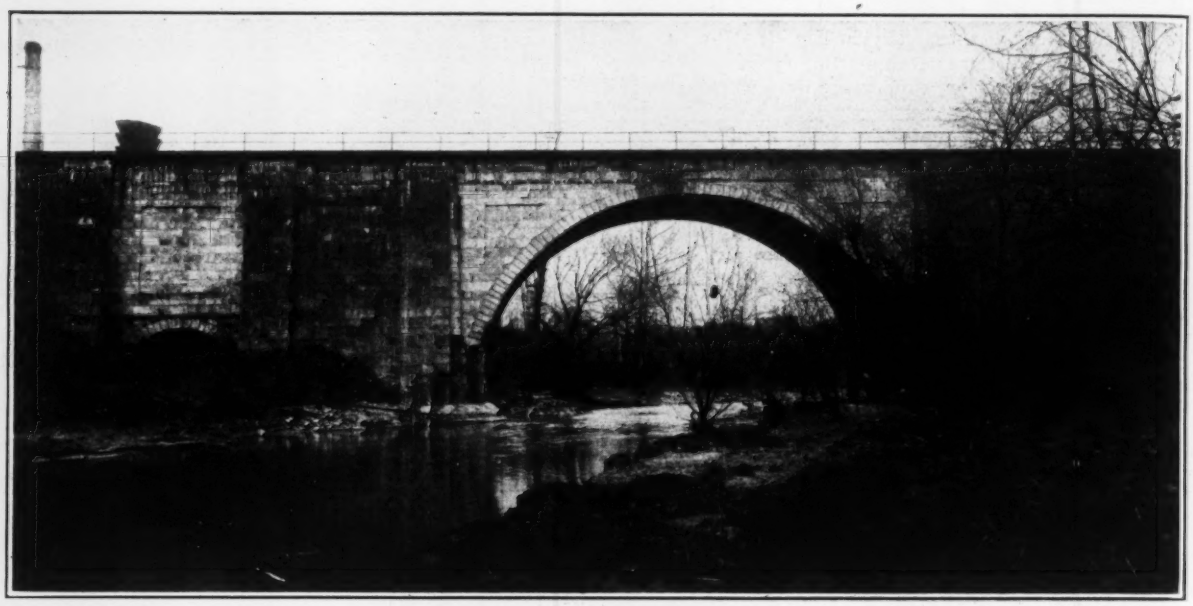
Baltimore & Ohio Railroad One Hundred Years Old

First Railroad in this Country to Reach Century Mark Under Its Original Charter Granted in 1827

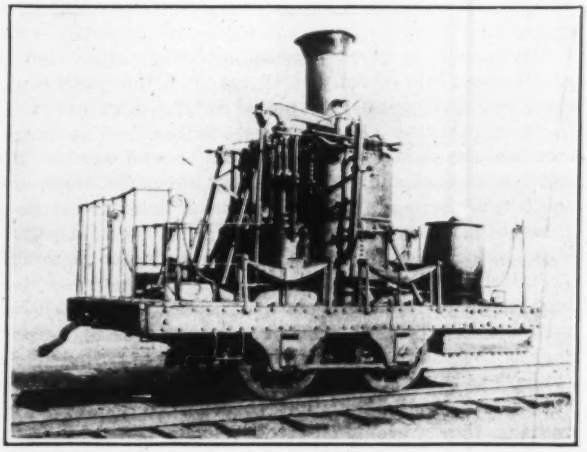
ONE HUNDRED years ago, on Feb. 28, 1827, the Baltimore & Ohio Rail Road Co. received its charter from the state of Maryland. Under that charter the company began construction of the railroad which it still operates. Thus it becomes the first railroad company in this country of which it can be said that it has been in existence for a full century. One other railroad, the Delaware & Hudson, has an older charter, but that was granted to it as a canal company and although the company built a short piece of railroad as part of its first transportation system, the operation of a steam locomotive on this railroad was not a success and horses were substituted. The D. & H. did not become a railroad operating company in the true sense until 1861. Another railroad, the New York Central, includes among its constituent companies the Mohawk & Hudson R.R. Co., chartered April 17, 1826, but it was not until 1853 that the Albany and Schenectady R.R., successor to the Mohawk & Hudson, consolidated with eight other companies to form the New York Central R.R. Claims also have been made that the Pennsylvania Railroad Co. operates under a charter granted more than a century ago, but such claims are based on a process of reasoning which is convincing mainly to those determined to establish the fact.

So much for the relative ages of the companies, the celebration of one hundred years of railroad operation in this country is still in the future. Many railroad companies were organized in the late 20's of the past century but the real beginning of the operation of railroads as part of the transportation system of the country did not occur until the late summer of 1831 when three companies, the South Carolina Canal & Rail-Road Co., the Baltimore & Ohio Rail Road Co. and the Mohawk & Hudson Rail Road Co., began operating regular train service. The locomotive West Point of the S.C.C. & R.R. was put into regular service on July 15, the York of the B. & O. on Aug. 30, and the DeWitt Clinton of the M. & H. on Sept. 24, 1831.

Following the granting of its charter, subscription books for the stock of the Baltimore & Ohio Rail Road Co. were opened March 31, 1827, and a total of $4,178,000 was subscribed. Meanwhile, surveys had been begun for a railroad line from Baltimore with the Ohio River as its ultimate destination. As was customary in those days the company turned to the U. S. Army for an engineer to make its surveys and Col. Stephen E. Long was detailed to it for that purpose. He was assisted by Jonathan Knight, an engineer of experience



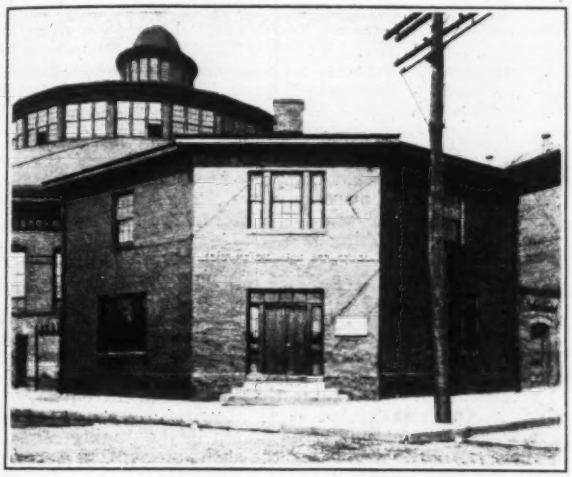
CARROLLTON VIADUCT, BALTIMORE, MD.
Built in 1829 and still in use; the oldest railroad bridge in this country, probably in the world.



LOCOMOTIVE "ATLANTIC" BUILT IN 1832
Built by Phineas Davis at York, Pa., for the B. & O. R.R. and used for many years. It is still capable of operating under its own steam.

in locating canals in Pennsylvania. The location of the B. & O. east of Harper's Ferry is largely the result of their skill in the then new art of railroad location.

Actual construction started July 4, 1828, when Charles Carroll, last surviving signer of the Declaration of Independence, broke ground for the laying of the "first stone of the Baltimore & Ohio Rail Road" on what now is the Mount Clare branch of the B. & O., and within 500 ft. of the Carrollton viaduct, built by the railroad company in 1829, the oldest stone arch railroad bridge in the world, which is still used for the heavy railroad traffic of today. By 1831 the railroad



OLDEST PASSENGER AND FREIGHT STATION IN AMERICA
Original station built in 1830 and still used for railway purposes.

had been built as far as Frederick, Md., 61 miles, and on Dec. 1, 1834, it reached Harper's Ferry, W. Va., a distance of 81 miles. From then on progress over the Allegheny Mountains was slow, the line through to the Ohio River at Wheeling, W. Va., 379 miles, not being completed until Christmas Eve 1852. The first train reached Wheeling Jan. 1, 1853.

Early Operation—Operation of the first 13 miles to Ellicott City, Md., was begun with horses but in 1829 an attempt was made to use a steam locomotive called the Tom Thumb, designed by Peter Cooper. The experiment was not a success and operation with horses was continued until in August, 1831, the York was put into service, as noted above. The York was built by Phineas Davis of York, Pa., weighed 3½ tons and was capable of hauling 15 tons at 15 m.p.h. on level track. On the first trip westward it hauled four cars weighing about 14 tons and reached a maximum speed of 30 m.p.h. The fuel was anthracite coal. From that date trains were operated regularly between Baltimore and Ellicott's Mills.

In 1832 the locomotive Atlantic, also built by Phineas Davis, was bought. It was an improvement over the York and was used for many years. The York is not in existence but the company has a reproduction giving its details. The Atlantic, however, has been preserved. It is pictured on the opposite page.

It was on the Baltimore & Ohio that electricity was first employed as a means of communication, the company having the first telegraph lines in the world over which Prof. S. F. B. Morse sent his first message. The company was also the first to employ electricity as a motive power.

Annual Yield of Driven Wells at Lowell, Mass.

By Robert J. Thomas
Assistant City Engineer, Lowell, Mass.
Formerly Superintendent of Water-Works at Lowell

THE accompanying table gives the annual yield of the driven wells from which Lowell, Mass., has obtained its water supply for the last 32 years. This yield might have been greater had the consumption so demanded, but not much greater, and it was only by reducing and keeping consumption to a low point that the supply was found adequate. To further make both ends meet, the wells had to be washed and cleaned regularly. Old and clogged wells had to be replaced and new ones added from time to time.

The supply continues undiminished, but should the requirements of the city increase, the prospects of obtaining more well water are not very encouraging.

The quality of the water has been very satisfactory,

YIELD OF DRIVEN WELLS OF LOWELL, MASS., FOR 32 YEARS
Millions of gallons per year from each of three groups of wells

Year	Boulevard 169—2½ in.	Cook 90—4 in. and 6 in.	Hydraulic 130—2 in.	Remarks
1895		897	814	
1896	1,051	574	781	
1897	1,187	542	512	
1898	1,065	816	516	
1899	1,667	965	97	
1900	2,088	842	31	
1901	2,230	304	93	
1902	2,174	22		Hydraulic station discontinued
		90—6 in. and 4 in.		Cook wells lowered and cleaned
	345—2½ in.	120—2 in.		
1903	2,000	No pumpage		
1904	2,033	64		Cook and hydraulic wells, 210
1905	1,878	127		
1906	1,878	13		
1907	1,907	127		
1908	1,623	281		
1909	1,621	342		
1910	1,807	232		
1911	1,472	355		Boulevard pumpage kept down on account of iron
1912	1,456	410		
1913	1,527	591		
1914	1,669	429		
1915	1,794	151		85 Boulevard wells reconnected; excessive rain
	518—2½ in.			
1916	2,173	No pumpage		
1917	2,187	111		
1918	2,110	668		
1919	2,160	233		
1920	2,206	338		
1921	2,311	19		525 Boulevard wells, 90 Cook wells. Hydraulic wells cut off
	525—2½ in.	90—4 in. and 6 in.		
1922	2,175	106		
1923	2,187	111		
1924	2,287	72		Decrease in population
1925	2,114	100		
1926	2,016	102		

	Gallons
Daily average for boulevard wells only last 10 years	6,000,000
Daily average for boulevard wells only previous 10 years	4,500,000
Daily average for boulevard wells only first 10 years	4,750,000

probably more so than any surface supply which Lowell could have obtained in the past, or will secure in the future. The construction cost of the well supply, $700,000, was lower than a surface supply would have cost, but the cost of pumping is very high because it has to be pumped twice. The cost of pumping and filtering last year was about $50 per m.g.

Lowell is the only city of any size in New England that gets its water supply from other than a surface source. The Massachusetts State Department of Health is now advising that the city enter upon the provision of a surface supply.

[Water from the Lowell wells has been treated for ten or a dozen years to remove iron and manganese. For a report on investigations and proposed plan by F. A. Barbour, consulting engineer, see *Engineering News*, July 9, 1914, p. 197.—Editor.]

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Iron in Sewage Treatment

Sir—The article by Abel Wolman on the "Role of Iron in the Activated Sludge Process" and the editorial comment on this subject in your issue of Feb. 3 are both extremely interesting.

Some years ago, I made some laboratory experiments on sanitary privies of the tank type. In some of these experiments, ferric chloride and in others ferrous sulphate were added in small quantities. (The notes are not now at hand.) The effect of the ferric chloride was almost magical, changing in about one day an offensive yellowish liquid to a blackish sweet smelling one containing material resembling well digested sewage sludge. The results produced by ferrous sulphate were similar, but not so striking nor so rapid. The good results persisted during subsequent loading.

These experiments suggested that iron is beneficial in producing good sludge digestion and that its use might be of great advantage in Imhoff, septic or other sludge digestion tanks which are not producing a good sludge. It would be interesting if some one who is in possession of the necessary data would work out the correlation, if any, between the iron content of various raw sewages with the quality of sludge produced.

C. P. RHYNUS,
Sewerage Engineer, City of Orlando.

Orlando, Fla.,
Feb. 8, 1927.

In Defense of Current Meters

Sir—With reference to Mr. Hoyt's letter, p. 1010 of your issue of Dec. 16, 1926, it is evident there exists an argument as to the relative merits of various current meters. Is this the attitude for professional engineers to assume? I have had as varied an experience with all types of current meter as any engineer, and am sure that good work can be done with any of them.

One of the principal troubles comes from the fact that the usual still-water rating cannot be relied upon when the meter is subjected to conditions of turbulent flow. If extreme accuracy is required, as in turbine testing, then it is necessary to employ more than one type of meter, unless most unusual conditions of quiet flow exist, as in long, straight uniform canals.

In selecting two different types of meter for simultaneous use in a gaging section, a meter of the cup type (Price, for example) and a meter of the propeller type (Ott) should be chosen—for meters of the former type *over*-register in turbulent water while those of the propeller type, unless of very unusual design, *under*-register. The discrepancy between the two velocities given by the two meters is then a criterion of the degree of error, and is generally greater than the error of either meter.

Moreover, a composite rating may be made from which a plane composite isogram can be plotted showing the true velocity as a function of the two velocity observations at the same point in the gaging section, the velocity by one meter being one co-ordinate, the velocity by the other meter being the other co-ordinate, and the true velocity being read from the isographic curves.

That meters were subject to such errors seems to have been known to engineers for many years. Among the first, if not the first, to make positive statements as to the facts was the late Charles H. Miller, formerly of Little Rock, Ark. (See *Engineering News*, Jan. 24, 1895, p. 58, and similar remarks by the late Wm. Starling in his paper entitled: "The Discharge of the Mississippi River." *Transactions*, Am. Soc. C. E., Vol. XXXIV, p. 347.) Since these days careful engineers have taken proper precautions when compelled by circumstances to employ current meters in disturbed water.

The table which follows gives a comparison of the results of simultaneous discharge determinations made by current meters compositely rated, and by chemical method. The results are derived from an extensive series of turbine tests for the Aluminum Company of America at Massena, N. Y., on the St. Lawrence River. Three types of meter (Haskell, Price, Ott) were operated in the flume while the chemical test was being made.

TABLE 92* — COMPARISON OF DISCHARGES DETERMINED BY CURRENT METERS WITH THE SAME DISCHARGES DETERMINED BY CHEMICAL METHOD

Test No.	—Discharge Determined by— Current Meter	Chemical Method	Test No.	—Discharge Determined by— Current Meter	Chemical Method
	Sec.-Ft.			Sec.-Ft.	
G	1,663	1,662	N	1,785	1,777
H	1,662	1,664	O	1,783	1,768
I	1,662	1,666	S	1,676	1,640
K**	1,618	1,683	T***	1,628	1,662
L	1,648	1,647	U	1,505	1,513

Averages:—Current Meters, 1,663; Chemical Method, 1,668

*From a paper by the present writer entitled: "Chemi-hydrometry and its Application to the Precise Testing of Hydro-electric Generators," *Transactions*, Am. Soc. C. E., Vol. LXXIX, p. 951, (1916). Another extensive series of turbine tests is recorded in a paper entitled: "Characteristics of Cup and Screw Current Meters, Performance of these Meters in Tail Races and Large Mountain Streams, etc." *Transactions*, Am. Soc. C. E., Vol. LXXVI, p. 819 (1913).

**There were noted some irregularities in this test which would doubtless improve the results if corrected. Tests G, H, I, K, L, were arranged for the same discharge as nearly as might be by adjusting gates, output and other conditions.

***Meter rack jammed in this test delaying the meter observations until 17 minutes after end of chemical test.

The chemical tests were extremely accurate, being self-consistent within a fraction of a single per cent and harmonizing with the power output to the same degree of precision. The electrical output was measured by the most sensitive and precise types of potentiometers, at great expense. The current meter determinations were based upon composite ratings, and they show a similar degree of precision, notwithstanding that individual current meters of any type represented were shown to have errors of several per cent at numerous points in the gaging section.

There can be no doubt that the still-water rating does not apply exactly in running water, but, when the gaging section is carefully selected and the action of the meter is understood by an intelligent engineer—and this is the only kind we acknowledge to be an engineer—we may rely upon the results as being satisfactory for the purposes of stream gaging.

There seems to be no reason for criticism of the performance of any type of meter. Different types of meter are simply different types of measuring instrument. Each type must be calibrated. If there is any error in results it is due to error of the engineers in applying the instruments. Because one engineer prefers to use a particular make of instrument is no reason why he should criticise the practice of other engineers who prefer to use a different make. A good engineer simply adapts his practice to the type he employs. "Accepted practice" in the general sense is often a dangerous practice, because it is so apt to become perfunctory practice.

When it comes to reliability, as determined by identical performance at different times under identical conditions, it is certain that any of the standard instruments will give satisfaction, though it may be that some instruments require a greater degree of attention under some circumstances than other instruments. One of the most consistent of all the instruments is the Price current meter.

The statement that screw meters ensnare weeds and the like is misleading to the extent that it does not apply to a properly designed runner, in fact such a design (Haskell) is as safe in this respect as any cup meter.

BENJAMIN F. GROAT,
Consulting Engineer.

Philadelphia, Pa.
Feb. 4, 1927.

On Expansion Joints in Concrete Roads

Sir—Referring to the matter of expansion joints now under discussion among highway engineers, apparently there must be a considerable number of engineers favoring the elimination of joints who have not taken certain fundamental laws into consideration, or at least are ignoring them, which is just as dangerous.

It is a fundamental law that the working stress applied to any structural material should not exceed the elastic limit of that material, and anyone who habitually uses the

testing machine to check up his theories knows that any homogeneous material subjected to breaking stresses is likely to be ruined at other points besides that where actual, visible rupture occurs.

Perhaps the chief effort of highway engineers is to see that the material in a concrete highway is as homogeneous and uniform in cross-section as it is practicable to make it; therefore, when contraction stresses become so great as to pull the concrete in two, there isn't the slightest doubt but that the whole pavement is damaged. It is amazing that any considerable number of engineers could lose sight of the principles involved here, nor is it flattering to the engineering profession.

E. O. KEATOR,
Civil Engineer.

Dayton, Ohio,
Jan. 22, 1927.

Herminghaus Decision Defended

Sir—Your editorial of Feb. 3, relating to the California supreme court decision in the case of Herminghaus vs. Southern California Edison Co., entitled "Doctrine Against Progress" causes one to say "Let us pray." It would appear there is nothing left but prayer if the decision says, as the editorial asserts, that "California's highest court has decided that the floods of streams must be perpetuated. . . and that streams may not be made uniform in flow," from which it is reasoned, first, that "the storage of water for use is prohibited," and second, that "the regulation of streams to prevent flood damage is rendered impossible." From this one would conclude that the situation respecting the storage of flood waters in California is hopeless unless the decision is overthrown.

The riparian doctrine has prevailed in California for many years. Under it neither power nor irrigation development has been checked. To the contrary, California excels all other western states where the appropriation doctrine is in force, in successful hydro-electric and irrigation enterprise. In fact, great expansion of both has taken place in the eighteen years which have transpired since the supreme court of California decided the case of Miller and Lux v. Madera Canal Co., establishing the doctrine that a lower riperian owner whose lands are so situated as to be flooded at the highest stages of the stream may restrain an upper appropriator from diverting such flood flow. It would seem that in the Herminghaus case the court affirmed this doctrine, and also it decided that an upper riparian owner could not store flood waters for future use under the exercise of his riparian right. This decision would seem to be sound and just to a lower riparian owner. But despite this it does not prevent an upper riparian owner from storing flood waters, for the reason that he may file an application under the California Water Commission act for an appropriative right to store and use such waters. Such rights, subject to prior rights, are regularly granted by the California Water Commission. The Southern California Edison Co. possessed such a right but seems not to have emphasized this fact in the lower court.

Storage of water in California for the use of power and irrigation has been accomplished without undue difficulty, but of course just compensation had to be paid by the interests making the storage development to those who were likely to be damaged or to have rights taken from them. As stated, this has not checked progress in the least, and storage works can be constructed in the future in the same manner they have been in the past. When interests who have endeavored to accomplish storage works have been unable to purchase rights that are necessary, at a reasonable price, resort has been had to the court under the right of eminent domain, which gives such interests the power to condemn. Practically all of those agencies who need to effect the storage of flood waters have this right and power. Such agencies are privately owned power and water companies who are in the public service, and municipal and quasi-municipal corporations such as irrigation districts. With perhaps minor exceptions, there have thus far been no other agencies concerned in the storage of flood waters. In the future these agencies together with the state and county, and other public agencies, which might desire to effect the storage of flood waters for flood control or other purposes, should have no difficulty.

On the whole, the decision in question does not seem to be reactionary, nor does it stand against progress. It does not come in conflict with the California Water Commission act, except with respect to Section 42 and part of Section 11. Despite this, the California Water Commission may continue to grant the right to appropriate water, subject to prior rights, as it has done since the act was passed. No fair-minded person would contend, for a moment, that an appropriator should ever have a right granted to him which is not subject to prior rights. In the case in point it seems beyond the peradventure of a doubt that the Herminghaus lands had certain prior rights concerning the use of floods at the high stages of the stream, and that the waters of the stream were, and had been, for many years, beneficially applied to the lands riparian to the stream.

So, it would appear that all that any agency which needs to store waters would have to do in the future is that which has been done in the past, namely, to acquire all of the rights that may be necessary at the best price that it can in face-to-face negotiations. And, if this cannot be done, it can exercise its right to eminent domain and condemn the rights it needs.

Thus far the cost of acquiring rights that may have been necessary has never put power nor irrigation development beyond the range of economy.

Thus, the Herminghaus decision is not disastrous, and irrespective of the water-right school of thought, the riparian or appropriation, to which one may belong, it does not appear, after a review of the facts in the case, that there is any necessity for "viewing with alarm" the recent decision. However, it is regrettable that the case came up at all, because it will create a new group of nuisance values under riparian right claims less sound than the one in question, together with attendant and costly lawsuits; and it may cause a tendency to promote radical legislation to correct, what seems to some, a bad situation respecting the principle of the greatest good for the greatest number of people. This will be upsetting to the common-law doctrine of riparian rights which has functioned with much success in California for many years.

To be laconic, as is the editorial, the late decision says in effect, but not in words, that the lower riparian proprietor shall not have a property right taken away from him without just compensation even though the property right be needed for public use; or, expressed even more broadly, the decision affirms the even greater doctrine of the sanctity of private property.

"AMI DE MOUVEMENT."

San Francisco, Calif.
Feb. 15, 1927.

[Our editorial endeavored to point out that a recognized nuisance, namely river floods, is legitimatized and given a cash value by the Herminghaus decision. We did not, of course, undertake to say that the property rights in this nuisance could not be bought off, or condemned; but we did mean to say that it is unsound policy to create property rights in a public nuisance.

Notwithstanding our correspondent's able defense the decision, in declaring a destructive phenomenon of nature to be a property right whenever one or more individuals claim to derive some advantage from it, is squarely against both common sense and the public good. Conservatism and progressivism have nothing to do with the case. Nor did we say anything against the riparian doctrine *per se*. But we feel safe in saying that if this doctrine can be maintained in California only by distorting it beyond the elastic limit and extending it to floods and flood channels, there is something wrong either with the doctrine in application to a sub-humid region or with the system of jurisprudence which finds this extension necessary; probably with both.

Our correspondent concedes that the decision will create "nuisance values." They are likely to be very large. Even if they should prove to be so small, however, as to place no serious burden on water development, the decision nevertheless must be "viewed with alarm" and deplored as a serious backward step. The cause of flood protection, for example, will be in a bad way if he who undertakes to free a community from the flood menace must first pay tribute to those who claim that they have a right to perpetuate this menace of nature. But we have no fear that any court outside of California will recognize the decision as a sound precedent.—EDITOR]

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Abrams Leaves Portland Cement Association

Is Succeeded by MacMillan with Gonnerman in Charge of Laboratory

Duff A. Abrams, for ten years the director of the research laboratory of the Portland Cement Association, has resigned to take up private practice. Mr. Abrams is widely known for his work in cement and concrete research extending back for the last twenty years, and best known for the development of the water-cement ratio for proportioning concrete which he first propounded in 1918, and which has been developed through a number of experiments and papers in the succeeding years.

He is a graduate of the University of Illinois, from which he received the degree of Bachelor of Science in Civil Engineering in 1905 and of Civil Engineer in 1909. After some early railroad and bridge work, he became attached in 1905 to the Engineering Experiment Station of the University of Illinois where he started his research career. There he was connected with the experimental study of concrete, reinforced concrete, timber, steel and brick.

One of the earliest of his experimental operations which came to formal notice was the testing of a full sized reinforced-concrete highway bridge for the Illinois Highway Commission. In 1912 he became professor in charge of the Structural Materials Research Laboratory of the Lewis Institute in Chicago, which in 1916 was taken over by the Portland Cement Association. Since that time Professor Abrams has been in charge of all Portland Cement Association research activities, more recently as director of the research laboratory which was instituted in the new building of the association last summer. He is the author of many papers and articles and is a member of many technical societies.

McMillan New Director

The Portland Cement Association announces that F. R. McMillan, now manager, Structural and Technical Bureau of the association, has been appointed director of research to have charge of all investigations in cement and concrete for the association. Mr. McMillan has been connected with the association since April, 1924. Prior to that time he had been in consulting practice in Minneapolis, on the staff of the Turner Construction Co. in New York and in charge of concrete ship design for the government during the war. For nine years he was on the faculty of the University of Minnesota in charge of concrete design in the concrete laboratory. He is a graduate of that university, having been graduated with a C.E. degree in 1905.

It is also announced that H. F. Gonnerman, associate engineer of the research laboratory of the association, has been appointed director of the laboratory. Professor Gonnerman joined the staff of the laboratory in 1922. Prior to that time he was in private business in the Far West and from 1908 to 1920 was on the faculty of the University of Illinois, of which he is a graduate. Professor Gonnerman is joint author of many of the research laboratory bulletins and the author also of a number of technical and scientific papers.

Engineering Fifty Years Ago

From *Engineering News*, March 3, 1877

WORK on the East River bridge progresses slowly. The foot-bridge from anchorage to anchorage has been laid for over a week, and persons crossing at Fulton Ferry have usually had the opportunity of watching the progress of somebody walking along unconcernedly, 250 ft. above them. A few reporters have taken the trouble to cross on this foot-bridge in order to see what their sensations would be. One of them said Mr. Martin, the superintendent, gave him permission because he did not expect the reporters would give him any peace until they had all gone over and some half a dozen had broken their necks by falling off or jumping off. The foot-bridge is for the convenience of the workmen in going back and forth while engaged in forming the great cables.

Hetch Hetchy Project Will Need More Funds Next Year

A report from San Francisco's city engineering department to the public utility committee of the board of supervisors states that the $10,000,000 Hetch Hetchy water bond issue voted in 1925 will be expended by the end of the present year and that in order to complete the project another bond issue or issues to the amount of $24,000,000 will be necessary. Of this amount, $16,000,000 will be for tunnels and $8,000,000 for pipe lines. The Hetch Hetchy project, it was pointed out, does not include a distribution system and the purchase of the Spring Valley Water Co. properties, on which the city has an option of $37,000,000, is contemplated as a necessary adjunct to a complete water system.

Concrete Institute Holds Record Meeting

Largest Attendance Yet Recorded Registers at Twenty-Third Annual Convention

Engineering News-Record Staff Report

Exactly 650 members and guests were registered at the 23rd annual convention of the American Concrete Institute held in Chicago, Feb. 22-24. This is the record attendance at any meeting of the association, even including the very successful 20th anniversary convention three years ago. Not only was there a large registration, but there was a very high percentage of attendance at all the meetings, which were concentrated into three days, instead of being distributed over four days with open intervals as in the past. Five of the eight sessions were devoted to engineering and construction and the generalities of concrete itself, one to architectural subjects, and two to the specialties of concrete products.

Committee reports were minimized this year. Only eight committees reported, and of these only three reported specifications. Committee S-6, Concrete Roads and Pavements, presented some tentative specifications for concrete curb and concrete curb and gutter which were accepted. Committee P-1, Standard Concrete Building Units, submitted three specifications, on which the following action was taken: The specifications for concrete manhole and catchbasin blocks were accepted as tentative. The proposed standard specifications for concrete building block and concrete building tile, which were adopted as tentative in February, 1926, were adopted to be sent to letter ballot of the Institute as standard. The proposed standard specifications for concrete brick adopted as tentative specifications in February, 1926, were submitted by the committee to be adopted as standard but by vote of the meeting were continued as tentative standard.

Committee E-1, Reinforced-Concrete Building Design and Specifications, submitted Building Regulations for the Use of Reinforced Concrete which have been before the Institute for two years as a preliminary draft. The only change in the document was to add to the list of acceptable aggregates blast furnace slag and to give a specification for that material. A discussion on the floor arose in the matter of the clause which relates to rerolled steel reinforcement. These proposed building regulations restrict the use of hard grade billet steel or rail steel to bars ⅝ in. in size and smaller or for larger sizes where no bending is required. Considerable argument developed as to the propriety of this exclusion of high carbon steel. Most of the argument in favor of the inclusion of steel rested on the fact that a great amount of such

steel was in satisfactory use. The chairman of the committee stated that the committee was open to conviction as to the propriety of the clause, but that the committee felt that it must stand on the present restriction until further evidence of the security of brittle steel has been adduced. It also felt that such evidence might come before the committee more quickly if the specification were submitted as tentative than if it were merely a document as it has been for the last two years. The question was put to vote of the meeting, at which there were about 300 present, and the committee's clause was upheld by a vote of 40 to 21. The proposed building regulations, therefore, were accepted as tentative standard for the Institute.

Committee C-6 on Field Methods, C-4 on Steel Forms, E-5 on Aggregates and E-3 on Research also presented reports, mostly of progress.

Three papers on large engineering structures were presented.

Under the modest title, "Notes on Concrete — Wacker Drive, Chicago," Arthur R. Lord, consulting engineer to the Board of Local Improvements of the city of Chicago on the design and construction of the South Water St. improvement presented a most interesting discussion of modern methods of making concrete, developed from his experience in the control of the concrete on that very large structure. Laying down 14 points required for the manufacture of good concrete, Mr. Lord cited his experience in developing these points and the deductions from those experiences. His major contention was that something more than the water-cement ratio is required in the design of concrete proportions, that consideration has to be given to the varying quality of the brands of cement, and the influence of the aggregate. He emphasized the importance of temperature in curing concrete, a factor which he felt had been generally disregarded. He urged the need of controlling consistency and the further need of precise control of all materials, of all manufacturing and transporting, placing and curing operations, and of the methods of measuring the strength of concrete in the structure. Finally, he laid weight upon the importance of personnel, not only of foremen but of workmen themselves, and gave credit to the city authorities of Chicago for the aid they gave him in resisting political influence which would have required methods and materials unsatisfactory to the engineer.

Other Papers

Lt. Comdr. J. J. Manning of the Civil Engineering Corps, United States Navy, presented a paper on the Bremerton Pier, which is described in this issue of *Engineering News-Record*. The design and construction of the Grandfey Viaduct was the subject of an elaborate paper by Adolph Buhler, chief engineer of bridges, National Swiss Rys. This paper had been originally written in German by Mr. Buhler and was sent in very much enlarged form to Prof. George E. Beggs, of Princeton University, who made the translation and abstract, which he presented for Mr. Buhler at the convention. The viaduct is a series of high concrete arches replacing an old wrought iron truss viaduct and the construction had to be carried on during the operation of the railway across the viaduct. Mr. Buhler's paper is an elaborate discussion of the design and the construction. It was particularly interesting in that the analysis of design was made on an assumption of an elastic frame for the whole viaduct, the calculations being made both by mathematical analysis and by the model investigation which has been developed in this country by Prof. Beggs. The rigid-frame theory permits very much lighter structure than would be by the ordinary concrete-arch theory.

Two papers on theory of concrete structures were presented, one by Albert Smith, consulting engineer of Chicago, on the design of concrete buildings for wind stresses; the other on the reinforced-concrete column by P. H. Markmann, consulting engineer of St. Louis. Mr. Smith's paper analyzed the effect of wind on the ordinary concrete frame and developed the idea that further reinforcing was normally required to resist wind in the lower side of the beams at the column connections. Mr. Markmann's paper attacks the Joint Committee's theory of column design.

Discussions on Materials

Four major papers were presented on materials. G. F. Loughlin, geologist of the United States Geological Survey, discussed the qualifications of different kinds of natural stone for concrete aggregate. His paper was a survey of the geological properties of the various stones used for aggregate in this country and is preliminary apparently to a further survey of specific kinds of aggregate. The major point of Mr. Loughlin's paper of interest to practical concrete users is that there are a number of aggregates which are structurally unstable and that this instability is a danger in a stone inside of concrete almost as much as though it were exposed to the weather. Dr. R. H. Bogue, in charge for the Portland Cement Association of the research at the United States Bureau of Standards, elaborated somewhat further than he had before on the results of the co-operative studies of cement that are going on in the Bureau. Prof. H. J. Gilkey, of the University of Colorado, submitted a series of tests which tend to demonstrate that coarse aggregate in the concrete is a field for needed research. Prof. Gilkey's tests were made on mortars and on concrete of the same mortars but different aggregate and he found that the sometimes accepted belief that the strength of a concrete is as the strength of its mortar was not always true. He submitted these tests merely as a reconnaissance series, with a view to advising further study along this line. Prof. T. Yoshida, of Kyushu University, Japan, described a test for workability of concrete which he had devised when taking advanced work at the University of Illinois. This is a sort of flow-table test, the distinction between it and the flow table being that the specimen is dropped a distance onto the table rather than as in the flow table merely being allowed to spread from a lifted form.

The final two sessions of the convention were given over to the theme "Time as a Factor in Making Concrete." P. H. Bates, of the Bureau of Standards, in his paper entitled "Why Time Is a Factor in the Study and Use of Cement," pointed out that the water-cement ratio is not constant, and that the time element is important, for water may evaporate from a concrete or pass away in some form, so that the amount put in is not a true measure of the amount that acts. The point was carried further by P. H. Johnson, of Sioux City, Iowa, who described the pavements that were started some years ago in Sioux City and have been used successfully in the Middle West. In these pavements, the concrete is placed on a fairly absorptive subgrade in wetter mix than is generally thought desirable. This is worked and reworked by hand floating and finally a dry cement-sand mixture is worked into the top, the idea being to draw out through the bottom and into the drier surface the excess water of the concrete. The idea was carried further by J. J. Earley, architectural sculptor, of Washington, D. C., who, in talking about stucco, said that proper stucco is placed over wet and the excess water is sucked out by the undercoat. He emphasized the idea of time as a factor by saying that it is the craftsman's skill which decides just at what time the stucco is properly workable. He emphasized two water stages in the making of stucco and presumably of concrete; one, the stage of making and one the stage of setting. The first stage is the water relation to the cement and concerns the strength of the mortar or concrete; the second is the water relation to the combined cement and aggregate and concerns the workability of the concrete.

Further papers on this theme were delivered by Duff A. Abrams, of the Portland Cement Association; W. Paul Eddy, who described concrete cast in sand molds; F. F. Longley, the concrete pipe made by the centrifugal process; and George Chandler, concrete products made by dry tamping.

Architectural Session

One evening of the meeting was devoted to an architectural session in collaboration with the Illinois Section of the American Institute of Architects. F. L. Ackerman, an architect of New York, read a paper on a preliminary note on concrete design, the architectural theory; Frank B. Austin, an architect of Los Angeles, on the use of concrete on the Pacific Coast, and Irving K. Pond, an architect of Chicago, on architectural uses of concrete.

In the business section of the Institute, an amendment to the bylaws was passed by letter ballot, whereby the dues are to be raised from $10 to $12.50 a year. The same officers were continued for next year. The president is Maxwell M. Upson, vice-president and general manager, Raymond Concrete Pile Co. The secretary is Harvey Whipple, 2970 West Grand Boulevard, Detroit, Mich.

It was announced that up to the time of the meeting, the membership had reached 2,390, which is a remarkable increase, when it is considered that in 1920 it was just about 400.

Building Supervision by Engineer or Architect Required by Bill

Senator Dunnigan, of New York City, has introduced in the upper house of the New York State Legislature a bill to introduce improved procedure in the planning and execution of building work involving structural safety. Its essential feature is that it requires both the preparation of plans and the supervision of execution to be done by a registered architect or licensed engineer. The essential features of the bill are outlined in the following.

"Structures of a public character," to which the bill refers, are defined as buildings of public assembly, amusement or instruction; hospitals, stores, factories, public garages or warehouses; and "any other building more than three stories in height or more than 35 ft. in height, except a private residence for one or two families and except a private barn, a private stable or private garage." Both the alteration and construction of such buildings are included, provided the alteration affects the structural safety of the building. All such buildings "shall be designed and the erection, alteration or conversion thereof shall be supervised" by an architect registered under the state law or an engineer licensed under the state law who has specialized in structural engineering.

In his application for a building permit, the owner or his agent must submit plans signed by the architect or engineer, accompanied by the owner's sworn statement that he will have all working drawings and shop drawings covering parts essential to the stability of the building checked and approved by the architect or engineer and that he will place the execution of the work under the direct supervision and continuous control of the architect or engineer. When the building is completed the architect or engineer must, within 10 days, submit an affidavit affirming his supervision and affirming the safety of the building. The building department is required to issue a certificate of occupancy upon the owner's application. Provision is made also for temporary certificates of occupancy covering completed parts of the structure.

Enforcement of the law is to be in the hands of the local building department or official where such exists, and elsewhere in the State Department of Labor, which now exercises control over certain building operations.

McGovern Recommended to Get N. Y. Subway Contract

The Board of Transportation of New York City has recommended that the contract for the construction of the 53rd St. tunnel from Manhattan to Long Island City under the East River be awarded to the Patrick McGovern Co. This company was the lowest of five bidders and its bid amounted to $10,481,550.

Though the bids were received on this work Oct. 15, 1926, action on them was delayed because of a taxpayer's suit which sought to restrain the city from proceeding with the construction of this subway. The complaints seeking to enjoin the city from such construction attacked the form of contract adopted by the Board of Transportation which contained provisions for the payment of the prevailing rate of wages, defined such a rate and provided for arbitration of any wage disputes between contractors and their employees. The Supreme Court, the Appellate Division, and the Court of Appeals each upheld the legality of the form of contract. (See *Engineering News-Record*, Oct. 21, 1926, pp. 650 and 679, and Nov. 25, 1926, pp. 856 and 885.)

The contract which it is recommended that the McGovern company receive will be for the first subaqueous section to be constructed in the city's new subway system. The deepest point in the tunnel will be 78 ft. under Welfare Island, where there will be constructed a ventilating shaft and emergency exit to the surface.

It is expected that the Board of Estimate and Apportionment will act upon the recommendation of the Board of Transportation at the meeting of the former board Monday, Mar. 7.

New Jersey Appropriates Money to Build Kill van Kull Bridge

By act of the New Jersey Legislature, approved by the governor on Feb. 15, $400,000 is appropriated as the first of five yearly installments totaling $2,000,000, to be used in conjunction with similar appropriations by New York, for the construction of a bridge across Kill van Kull, between Bayonne and Staten Island, New York harbor. The Port of New York Authority is to build the bridge. Its preliminary report, recommending a 1,600-ft. steel arch structure, was abstracted in *Engineering News-Record* of Feb. 17, p. 284.

New York State Engineers to Meet March 8

The New York State Society of Professional Engineers and Land Surveyors, whose organization meeting was held earlier in the year, will hold its first large open meeting at the Engineering Societies Building, New York City, March 8. Speakers for the evening include Dr. August S. Downing, deputy commissioner of education, the University of the State of New York; Col. Walter Graeme Eliot, chairman, State Board for Professional Engineers and Land Surveyors; Dr. J. Gardner Smith, president, Harlem Board of Commerce; Col. Hugh A. Kelly, secretary, New Jersey State Board of Professional Engineers and Land Surveyors; Edward J. Mehren, vice-president, McGraw-Hill Publishing Co., Inc.; Julius H. Cohen, chief counsel, Port of New York Authority; Alford J. Williams, alderman, city of New York; Arthur V. Sheridan, past-president, Association of Engineers of New York, and Raphael J. Smyth, vice-president, New York State Society of Professional Engineers and Land Surveyors.

The president of this new state association is James M. Welsch and its secretary, Edward T. Ebert.

Engineers to Select Site, Design San Francisco Bay Bridge

The San Francisco board of supervisors, after debate prolonged for months and marked by disputes, on Feb. 15 voted to ask the presidents of four local universities to prepare a list of qualified and disinterested bridge engineers from which could be chosen three who, with the San Francisco city engineer, would be charged with selecting the site and preparing preliminary plans for a bridge across the Bay from San Francisco to Oakland. The three engineers selected are to be instructed to make "a study and investigation of the proper location of termini, foundations, clearances above the waters of the bay, space between piers, the loads which said bridge should carry, the facilities for traffic at both termini of said bridge, and the probable conditions of traffic incident to said bridge, and the financial problems involved." The four universities named are the University of California, Leland Stanford, Jr. University, the University of Santa Clara and St. Mary's College. The resolution requests that the names of suitable engineers be submitted within ten days and that the engineers shall decide on the site within 30 days after they accept the commission.

Trade Commission Recommends Inquiry Into Holding Companies

The Federal Trade Commission in a report on the electric power industry made in partial response to a resolution passed by the United States Senate, has found that there is no evidence to support the claim that the larger manufactures of electric power machinery and equipment, dominate the power industry, through control of operating companies. It finds, however, that "one of the problems of public interest concerning some of the large electric power groups is the extreme degree to which 'pyramiding' has been carried in superposing a series of holding companies over the underlying operating companies so that in one instance less than a million dollar investment in the majority of the voting stock of the apex holding company gave in 1925 full control of the entire organization of the group, having scores of underlying companies and several hundred millions dollars of investment. Such pyramiding not only affects the financial stability of the electric power industry, but also has a potential relation to the more general question of an undue concentration of control in the electric power industry. As the extensive grouping of electric power companies often brings their business into the field of interstate commerce, it presents a problem that calls for legislative consideration by Congress."

The inquiry was directed chiefly into the relation of the General Electric Co. to the power industry through the Electric Bond and Share Co. On this subject the commission found that since the time that the General Electric Co. had divested itself of its interest in the Electric Bond and Share Co. there was nothing to indicate that the latter company was not directing its own affairs.

A. R. Decary Elected President of Canadian Institute

At the annual meeting of the Engineering Institute of Canada held at Quebec, Feb. 15-17, which was attended by 300 members, A. R. Decary of Montreal, was elected president and J. H. Hunter, Montreal; V. J. Porter, Calgary; Peter Gillespie, Toronto; W. G. Mitchell, Quebec; and G. D. McDougall, New Glasgow, N. S., were elected vice-presidents.

Mr. Decary was born in Montreal in 1875. He received his education at St. Mary's College and the École Polytechnique de Montreal. He was for some years engaged in hydrographic work for the Canadian Department of Public Works, and in 1905 was appointed district engineer of Quebec. In 1913 Mr. Decary was appointed superintending engineer, having jurisdiction over the province of Quebec for the Canadian Department of Public Works. He has been intimately connected with all the important river and harbor works carried out by the Dominion.

Mr. Decary has taken a prominent part in the work of the Institute to which he devoted much of his time. He was elected vice-president in 1924 and was one of the chartered members of the Quebec branch of the Institute of which he was chairman for some years. He was largely instrumental in the establishment of the Corporation of Professional Engineers of Quebec, being president since 1920.

The Institute awarded several medals, including the Gzowski Medal to Leslie Rielie Thomson for a paper on "The Fuel Problem in Canada," and the Plummer Medal to Dean C. J. MacKenzie and Professor T. Thorvaldson. At the annual banquet held on the evening of Feb. 16, Sir Henry Thornton, president of the Canadian National Rys., was the chief speaker.

Commerce Commission Upheld in Fixing Railway Values

The United States Supreme Court in the case of the United States versus the Los Angeles and Salt Lake R.R. Co., has upheld the commission's right to fix final values upon the various railroad properties throughout the country without passing upon the legality of the method used by the commission in finding such values.

Suit was brought in the federal court for Southern California by the Los Angeles and Salt Lake R.R. Co. to enjoin and annul an order of the Interstate Commerce Commission purporting to determine the "final value" of its property under Section 19a of the Act to Regulate Commerce as amended by the Valuation Act of 1913. The bill asserted that the order fixing the final value is invalid because it is in excess of the powers conferred upon the commission, is contrary to the provisions of the Valuation Act and violates the fifth amendment to the Constitution. It charged that the valuation was made as of June 30, 1914, whereas it should have been made as of June 7, 1923, that the value found is for rate making purposes, whereas the finding should have been a general one of value for all purposes: and that in making the finding of value the commission erroneously failed to consider specific elements of value. The district court in California entered a decree annulling the final valuation order and enjoining its use for any purposes. In so doing, the Supreme Court finds that it erred, that it should have dismissed the proceedings on the basis that the so-called order of the commission is one which "does not command the carrier to do, or to refrain from doing, anything; which does not grant or withhold any authority, privilege or license; which does not extend and abridge any power or facility; which does not subject the carrier to any liability, civil or criminal; which does not change the carrier's existing or future status or condition; which does not determine any right or obligation.

"The so-called order is merely a formal record of conclusions reached after a study of data collected in the course of extensive research conducted by the commission through its employees. It is the exercise solely of the function of investigation. * * * The investigation * * * was merely preparation for possible action in some proceeding which may be instituted in the future—preparation deemed by Congress necessary to enable the commission to perform adequately its duties, if and when occasion for action shall arise. * * * But Congress did not confer upon the courts power either to direct what this 'tribunal appointed by law and informed by experience' shall find, or to annul the report, because of errors committed in making it."

In conclusion the Supreme Court said: "The investigation was undertaken in aid of the legislative purpose of regulation. In conducting the investigation and in making the report, the commission performed a service specifically delegated and prescribed by Congress. Its conclusions, if erroneous in law, may be disregarded. But neither its utterances nor its processes of reasoning as distinguished from its acts, are subjects for injunction."

Large Prizes for Treatises on Arc Welding

The American Society of Mechanical Engineers has accepted the custody of $17,500 offered by the Lincoln Electric Co., Cleveland, to be awarded by the society in world-wide competition for the best three papers disclosing advancement in the art of arc welding. Three prizes will be awarded, the first $10,000, the second $5,000, and the third $2,500. There is a proviso that no awards be made unless the papers are considered of sufficient importance and value to justify such an award.

The American Society of Mechanical Engineers has issued a brochure explaining the details under which the competition is to be held, also embodying data and photographs illustrative of arc welding work. All papers must bear evidence of having been sent to the committee in charge of the American Society of Mechanical Engineers before Jan. 1, 1928.

Further details can be secured by writing Calvin W. Rice, 29 West 39th St., New York, who is the secretary of the society.

Three New Niagara Gorge Bridges Projected

Three projects for new bridges across the Niagara Gorge are under discussion. The most active is the project of the Cataract Bridge Co., headed by Edward C. Randall, of Buffalo, a bill for whose incorporation has been introduced in the New York Legislature. This incorporation is applying to the authorities on both sides of the line for power to construct a steel arch bridge to cost about $4,000,000, located between the existing upper arch bridge and the Falls, about on the line of Falls St. on the New York side and Clifton Hill on the Canadian side. The bridge is planned to be a double-deck structure, the upper deck to carry vehicular traffic and the lower pedestrian traffic. It would form a direct route between the business districts of the cities on opposite sides of the river.

A railway bridge has been planned to be built just north of the present Grand Trunk bridge or lower arch bridge. The Canadian National Electric Rys. is building a line to the Gorge and holds bridge heads on both sides near the Falls. However, construction work has been discontinued pending the decision of the Dominion Board of Railway Commissioners relative to crossings in Niagara Falls, Ont.

A third proposal has been made by the city council of Niagara Falls, N. Y. A resolution adopted by this body calls attention to the inadequate bridge facilities across the gorge, and suggests to the board of commissioners of the New York State Reservation at Niagara Falls that it take steps to secure a charter and an appropriation from the state to meet one-half the cost of a new bridge to connect the New York State reservation with Victoria Park.

Russian Soviet Retains Cooper as Dnieper Hydro Plant Consultant

According to official representatives of the Soviet Union of Russia in the United States, negotiations have just been completed whereby Col. Hugh L. Cooper, consulting engineer on the Muscle Shoals project and other large hydro-electric works, is retained by the soviet government as chief consulting engineer on the superpower project on the Dnieper River in the Ukrainian Soviet Republic. Col. Cooper recently came to terms with officials of the soviet government in Moscow, but final details were not cleared up until his arrival in this country.

The power and navigation project on the Dnieper River at Kichkas, the design and construction of which Col. Cooper is to supervise, will be built and financed by the soviet government and will cost approximately $70,000,000, requiring about six years to construct. An ultimate capacity of 650,000 hp. will be installed, storage to be supplied by the construction of a dam 120 ft. high. A flight of three locks will lift craft over this dam and will make the Dnieper River navigable from the Black Sea for a distance of about 600 miles through the coal, iron and wheat belt of the Ukraine.

Washington Notes

THE Washington Irrigation and Development Co. has applied to the Federal Power Commission for an extension of two years in the period allotted for the construction of its project at Priest Rapids on the Columbia River. While determined opposition to the extension is expected to be forthcoming from local irrigation and other interests, it is practically certain that the commission will grant the extension. The rights were not allowed until after full opportunity had been given all to present their views. Now that the company has expended large sums, in efforts to induce industries to erect plants in the region so as to provide a market for the 750,000 hp. which it is planned to install, and in other preliminary studies, it is very unlikely that the commission will cancel the rights already extended.

OBJECTIONS have been filed with the Federal Power Commission in connection with the application of the Northern Connecticut Power Co. for a license covering its project on the Connecticut River near Springfield, Mass. The company is not willing to incur the expense of providing locks in the new dam which will replace the Enfield dam. It is willing to construct its dam in such a way that the locks can be put in by the Federal Government at any time it sees fit. The power company points out that the head of commercial navigation on Connecticut River is at Hartford. The company contends that navigation above its dam is confined solely to pleasure craft. The company proposes to install 65,800 hp. in connection with its new dam.

THE Federal Power Commission on Feb. 12 departed from its resolutions to grant no rights in the Colorado River basin by issuing a license to the Best Flume and Power Co., of Pinedale, Wyo., a locally financed concern which is developing a small project for public utility use in Pinedale.

CONGRESSMAN WOOD has introduced into the House of Representatives a concurrent resolution, which has been referred to the Committee on Interstate and Foreign Commerce, recommending that the federal government in its purchases avoid by every fair means the encouragement of foreign materials in competition with American products. The resolution is based on the report of the director of the Bureau of Foreign and Domestic Commerce that indicates that 1926 exports fell off 2 per cent to the lowest level since 1910, and that imports increased 5 per cent for the same period. The resolution points out that many foreign commodities are being used in preference to like American commodities in the construction of buildings, roads, bridges, piers and other public works, a fact which puts the money of the American taxpayer in direct competition with his own business interests.

Fatal Snowslide at Tunnel Camp on Big Creek Project

A snowslide on Feb. 15 at tunnel camp 72 of the Southern California Edison Co.'s Big Creek project carried several of the camp buildings down the steep hillside and reports received up to the time this was written placed the death list at ten with three others missing. The Big Creek hospital had received twenty-two injured, four of whom were not expected to live.

Camp 72 is on a steep slope some 2,000 ft. above the town of Big Creek, and on the opposite side of the valley. It marks the portal of an adit on the Pitman tunnel that is to connect Huntington and Shaver Lakes, the camp having been established to house crews working on the tunnel.

From reports thus far available it appears that about half of the camp buildings were swept away by two snowslides. The first came about 2 a.m. and dislodged and crushed some of the bunkhouses in which the men were sleeping. The second, some hours later, added to the casualty list and increased the difficulty of rescue.

A.S.T.M. to Hold Committee Convention on March 15-18

Some twenty committees of the American Society for Testing Materials are to meet at a committee convention to be held at Philadelphia (Bellevue-Stratford Hotel) during March 15 to 18. Most of the materials dealt with by the society's committees will be represented, both metals and non-metals. This follows the practice established at the Providence committee convention last year. Previous committee conferences have been held in separate groups, metals and non-metals being segregated, but the new arrangement is believed to be more convenient.

Second Line of Water Tunnels for New York City Approved

Plans for an auxiliary deep-water tunnel for New York City, submitted by the Board of Water Supply to the Board of Estimate and Apportionment, Dec. 20, 1924, was approved by that body sitting as a committee of the whole on Feb. 28. The plans call for a main tunnel 17 ft. in diameter the greater part of its length, starting at the Hillview reservoir, Yonkers, and extending through the Bronx and under the East River to Astoria, and then to Fort Greene Park, Brooklyn. The cost of the project, as estimated in 1924, is $67,249,000.

Would Put Water Companies Under Public Service Commission

A bill to bring private water companies in New York State under the control of the Public Service Commission has been introduced in the New York Legislature. In general, it would give the commission the same control over incorporation, rates and character of service as the commission now has over gas and electric companies. Municipal works and works entirely for the supply of industrial companies are excluded from the terms of the bill.

Random Lines

Embalmed Ignorance

The accompanying photograph and "tribute" are taken from the February, 1927, issue of "The Straus Investors Magazine," the house organ of S. W. Straus & Co., Inc., the mortgage bond house.

Oh Engineer, Oh Engineer, What Crimes are Committed in Thy Name.

THE ENGINEER

There can be no one with greater responsibilities in connection with the erection of a building than The Engineer. From first to last he and his transit are familiar figures about "the job."

He it is who, working in terms of minutes and degrees as easily as we measure feet and inches, establishes the exact limits of the plot upon which the structure is to be erected and locates the lines of the building, itself both as to extent and grade. As soon as the foundations are completed and the first three or four floors of steel are erected he is back to "plumb the job," meaning that he verifies by transit and level the accuracy with which the work is being done.

Throughout the construction of the building he is constantly repeating this task, so that when the finished structure is delivered of its builders and is ready for occupancy it stands square and true from foundation, far below the surface of the street, to the highest stone in the tower.

The next time you pass along a busy city street stop to consider The Engineer, centering his plumb-bob over the tiny mark in the pavement which is his guide and squinting through the sights of his instrument as he wigwags to his assistants holding markers somewhere about the job. He is making certain that the structure, which as likely as not will be the security for the mortgage bond you will buy, is a good building in every sense that the word "good" can imply.

Engineering Societies

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, Ill., March 8-10, 1927.

ASSOCIATED PENNSYLVANIA CONSTRUCTORS, Harrisburg, Pa.; Annual Meeting, Harrisburg, March 24, afternoon, and March 25, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Asheville, N. C., April 20-22, 1927.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The San Francisco Section, American Society of Civil Engineers, held the regular bimonthly dinner meeting on Feb. 15. The paper of the evening was presented by George A. Posey, county surveyor, Alameda County, and chief engineer of the estuary tube project, the subject being "The Design and Construction of the Oakland-Alameda Estuary Subway."

The American Ceramic Society at its annual meeting Feb. 14 elected the following officers: President, B. Mifflin Hood, Atlanta, Ga.; vice-president, M. C. Booze, Cincinnati, Ohio; treasurer, H. B. Henderson, Columbus, Ohio; and general secretary, Ross C. Purdy, Columbus, Ohio.

The American Road Builders' Association announces the removal of its offices from 37 West 39th St., New York City, to the Earle Building, Washington, D. C.

A **Miami Section** of the American Society of Civil Engineers has been organized at Miami, Florida, membership to include any members of the national society residing in Palm Beach, Broward, Dade or Monroe Counties. The new section numbers 37 members.

The New Jersey Sewage Works Association will hold its 1927 meeting at the State House, Trenton, N. J., March 25.

The Florida Section of the American Water Works Association will hold its second meeting at Hollywood, Florida, April 12 and 13. E. L. Filby, P. O. Box 135, Jacksonville, is secretary of the section.

The Steel Works Section of the Engineers' Society of Western Pennsylvania held its annual meeting Feb. 23 at Pittsburgh. A. C. Fieldner, superintendent of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, gave an illustrated address on "Co-operative Research in Ferrous Metallurgy and the Problem of Inclusions in Steel."

The Duluth, Minn., Engineers' Club at its Feb. 21 meeting presented a one-reel film, loaned by the Du Pont Co., Wilmington, Del., showing scenes connected with the building the new 8th Ave. subway in New York City. The club announces a short course in cement and concrete work for March 8 to 10, to be held at the Central High School in the city.

The Western Society of Engineers lists the following papers on its program: March 7, "Construction of the Skokie Valley Line of the Chicago, North Shore & Milwaukee R.R."; March 18, "Transatlantic Telephone Service."

Personal Notes

EDWARD B. TEMPLE, whose promotion to be chief engineer of the Eastern Region, Pennsylvania R.R., was announced in our *Engineering News-Record* of Feb. 3, p. 210, was born at Concordville, Pa., Aug. 28, 1871, and graduated from Swarthmore College in 1891. In the same year he began work with the construction department of the Pennsylvania R.R. on surveys and inspecting construction work, including the extension of the Filbert St. Elevated R.R. and the Broad St. Station at Philadelphia. In March, 1897, he was transferred to the chief engineer's office in Philadelphia and in July, 1900, was appointed assistant engineer. The following year he was placed in charge of general drafting work and the design of masonry and steel bridges. He remained in that position until in April, 1905, he was appointed assistant to the chief engineer. In March of the following year he was promoted to be assistant chief engineer, which position he held until the advent of the United States Railroad Administration in 1918, when he was appointed engineering assistant to the director of the Allegheny Region. At the close of the federal administration in 1920, Mr. Temple was appointed assistant chief engineer of the Pennsylvania R.R., which position he held until his promotion to the newly created position of chief engineer, Eastern Region. Mr. Temple's recent work has included the charge of the preparation of plans for the Philadelphia terminal improvements which were agreed upon between the railroad and the city in July, 1925. In 1923 Swarthmore College awarded Mr. Temple the honorary degree of Doctor of Engineering.

FRANK E. WATERMAN, city engineer of Providence, R. I., has been appointed commissioner of public works at Providence, succeeding the late Milton H. Bronson whose death was recorded in these columns Jan. 20. Going back from the present in Mr. Waterman's engineering work, he has been city engineer of Providence since 1924 as well as deputy commissioner of public works carrying the latter work during several periods of illness of Mr. Bronson. Previously, Mr. Waterman was division engineer on construction of the Scituate reservoir as a member of F. E. Winsor's staff, after having for fifteen years been the head of a firm of engineers of his name doing general engineering work.

ANDREW F. ESCHENFELDER, has been appointed borough engineer of Glen Ridge, New Jersey. Mr. Eschenfelder has been assistant engineer, bureau of construction, engineering department of Essex County, N. J. He succeeds W. H. Dewar, who is entering private practice.

W. H. FRANKLIN, Springfield, Ill., an engineer with the J. Clyde Evans Construction Co., has severed his connection with the company to go into the general contracting business for himself, in Springfield and vicinity.

FREDERICK H. FAY, of Fay, Spofford & Thorndike, Boston, Mass., has been elected president of the American Institute of Consulting Engineers. Mr. Fay was for some years bridge engineer of the city of Boston, and is now chairman of the Boston City Planning Board and of the Boston Board of Zoning Adjustment. He has served the city and the state in many advisory engineering capacities. Formerly he was president of the Alumni Association of Massachusetts Institute of Technology.

ROBERT FARNHAM, Philadelphia, Pa., since 1923 engineer of bridges and buildings for the Pennsylvania R.R. for the section of the system east of Pittsburgh and Erie, has been appointed chief engineer in charge of Philadelphia developments and will have charge of the construction at the new Philadelphia station and work incident thereto under the direction of Elisha Lee, vice-president. Until now the railroad's improvement program in West Philadelphia has been under the supervision of the chief engineer and his assistants, but is now placed under Mr. Farnham who will devote his entire time to the work. Mr. Farnham has been connected with bridge and building construction for the Pennsylvania R.R, in many places, including the Washington, D. C., station.

HERBERT W. YEO, formerly county surveyor of Dona Ana County, New Mexico, and town engineer of the town of Las Cruces, has been appointed state engineer of New Mexico. Mr. Yeo was for thirteen years employed by the U. S. Reclamation Service on the several different irrigation projects in the western part of the United States. During the World War he was an engineer officer.

JOSEPH SUMMERS, until recently assistant in the engineer corps of the Pennsylvania R.R., has been made assistant supervisor of the Conemaugh Division. He is stationed at Blairsville, Pa.

SIDNEY H. OSBORNE, division engineer of the Colorado division of the Union Pacific R.R., with headquarters at Denver, Colo., has been appointed engineer of maintenance-of-way for the entire system and will move his headquarters to Omaha, March 1.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Conference to Consider Report on New Billet Steel Reinforcing

Organized consumers, technical experts, distributors and manufacturers interested in new billet steel for concrete reinforcement are invited to attend a conference in Washington, March 19, held under the auspices of the Department of Commerce. The conference is the result of the work of a committee appointed in late January to report upon what, from the standpoint of production, distribution and use grade or grades of new billet steel for concrete reinforcement should be recommended for adoption. The committee was appointed by the Director of Metals Utilization of the Department of Commerce. A joint conference on this subject was held under the auspices of the National Committee on Metals Utilization Jan. 26.

Chicago's Permanent Building Exposition Ready May 1

Chicago's permanent building materials and equipment exposition, to be housed in the Builders' Building, now nearing completion on Wacker Drive, will be opened to the public May 1. This exposition will give the prospective owner or builder of home, office building or industrial plant, in co-operation with an architect, the opportunity to make selections of materials from the basement plumbing to the cornice. Contractors will have here, for instance, the opportunity to see models of the steam shovels or other equipment that will do the excavation on their projects, as well as to learn methods by which leaders in the construction field are carrying on their work even during the coldest months of the year. This will be the first permanent exposition to show all phases of building. It will not be confined to Chicago exhibitors, but will include those of leading manufacturers and equipment houses of both this country and Europe.

Two hundred leading contractors and building supply men of the Middle West arranged with S. W. Straus & Co. to finance this $8,500,000 project with a $5,000,000 bond issue. The building, of 23 stories, is the result of years of planning and the responsibility for completing it is attributed to E. M. Craig, secretary of the Building Contractors Employers Association, who back in 1912 urged the need for such a plan.

Business Notes

GEORGE CUTTER Co., South Bend, Ind. and Westinghouse Electric Products Co., Mansfield, Ohio, have been discontinued as separate companies and are now merged into the parent company, the Westinghouse Electric & Mfg. Company. They will hereafter be operated as branch works designated as the Mansfield Works and the Street Lighting department. The Street Lighting Department will also include the South Bend Works which is one of the largest in the country devoted to the manufacture of street lighting equipment. It has branches for the manufacture of concrete poles located in Milwaukee, St. Louis and Valdosta, Ga. The Mansfield Works is devoted to the manufacture of domestic electric appliances.

ALFRED J. FORSCHNER, former owner of the Alfred J. Forschner Co. and of late connected with the Osgood Co. has entered the employ of the McMyler-Interstate Company, Cleveland, to work out of its Philadelphia office, specializing particularly on excavating equipment.

THE LIDGERWOOD MFG. CO., of New York, has established an office and warehouse at Jacksonville, Fla., 401 Barnett National Bank Building. This office will be in charge of L. C. Hastings, who has for several years represented the company in this territory.

FRED S. DORAN has been appointed manager of the Cleveland Plant of Joseph T. Ryerson & Son., Inc. This new warehouse plant of the Ryerson company was purchased from the Bourne-Fuller Co. on Jan. 3, 1927. Mr. Doran has been associated with Joseph T. Ryerson & Son for 21 years. Beginning in the office he traveled the Wisconsin territory for five years, then covered the Chicago City territory until he was made assistant to A. M. Mueller, general manager of sales.

THE MULTIFOOTE SALES CO. of 2811 West Fulton St., Chicago, general distributor in the middle western territory for the Foote Co., Inc., of Nunda, N. Y., announces that J. J. Stockberger will handle the sale of MultiFoote-Timken-equipped pavers in the Indiana territory. Mr. Stockberger is located at 317 Dunnwood Drive, Fort Wayne, Ind. In the Chicago territory the sale of MultiFoote pavers is handled by the Lowe-Peters Equipment Co. at 612 N. Michigan Ave.

THE T. L. SMITH CO., of Milwaukee, manufacturers of Smith mixers and pavers, has recently announced the appointment of John McNeilly, 335 South High St., Columbus, Ohio, as distributor in this territory for the Smith line of mixers and pavers. The New Mexico Road Machinery Co., of Albuquerque, New Mexico, has also recently been appointed as Smith distributors to serve more adequately increasing demands in the southwest.

YEOMANS BROTHERS CO., 1433 Dayton St., Chicago, manufacturers of pumping machinery and sewage ejectors, has appointed Purdy & Henderson Trading Co., Havana 55, esquina a Empedrado, Havana, Cuba, as sales representatives for that territory.

The KENT MACHINE CO., of Kent, Ohio, announces the opening of a conveying machinery division office at Chicago, 625 Monadnock Block, with F. E. Schwalb as manager and sales engineer.

New Developments

Folding Rules of Aluminum

A new type of folding rule is made by the Lufkin Rule Co., Saginaw, Mich. The advantages of these rules are their lightness and compactness and their greater accuracy as compared with wooden rules. They are made with graduations in feet and inches or in feet, tenths and hundredths, and are furnished with or without a folding end hook.

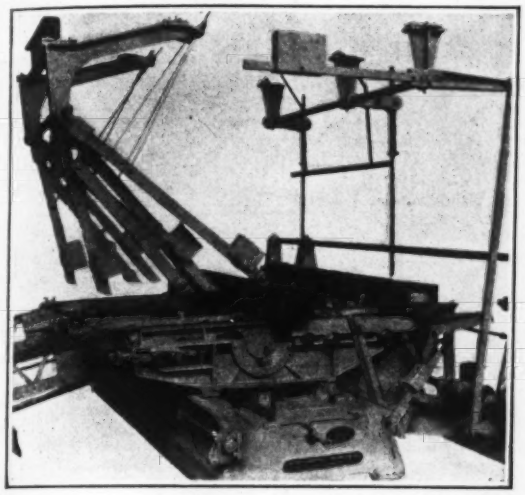
Track Shovel Improved by Adding Turned Steps

An improvement in the track shovel made by the Ames Shovel & Tool Co., of Boston, is a special shovel with turned steps on the upper edges. These shovels are made of an alloy steel designed to combine toughness with hardness in order to resist wear and yet be able to withstand severe bending stresses. The shovels are made with flat or square points. The company also is making a locomotive scoop of similar steel designed to meet the exacting requirements of locomotive firing where lightness combined with proper balance are the essential features of design and use.

New Tie Dressing Machine

A machine for trimming and boring railway ties at the rate of seven ties per minute has been brought out by the Yates-American Machine Co., Beloit, Wis. It automatically trims the ends, adzes the seats for rails or tie-plates, bores the spike holes and stamps the date, although the machine can be supplied without the trimming saws and stamping device if desired. The adzing shaft and feed apparatus are belt driven from a 20-hp. motor; the cast-steel rotary adzing heads are fitted with knives of tungsten high-speed tool steel. These heads can be

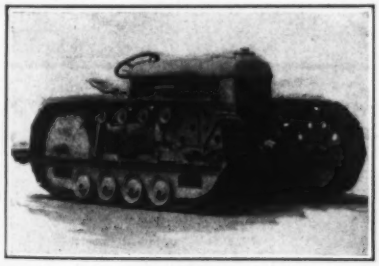
adjusted to cut any width from 11 to 15 in. and to make a shallower cut in sawed ties. The boring bits are geared to a pair of 7½-hp. motors, while the trimming saws are driven directly by two 15-hp. motors. These



saws, which slice off the ends of the ties, are adjustable for ties 8 to 10 ft. in length. A chain conveyor delivers the ties to the feed chains of the adzing device, which have sharp steel dogs to keep the tie from rocking under the tools. Conveyor rolls at the rear of the machine carry the finished ties endwise to a chain conveyor which carries them back and, if they are to be treated, delivers them to a tram on the same track from which they were passed to the machine. If the ties are to be stored, they may be delivered to roller gravity skids and thence elevated and dropped into a tie-tram on another track. An auxiliary device is an electric winch for handling the tie-trams at the machine.

Heavy Duty Tractor Built Around Fordson Power Unit

A new model crawler for Fordsons considerably heavier in design than its standard unit, known as Model D, is



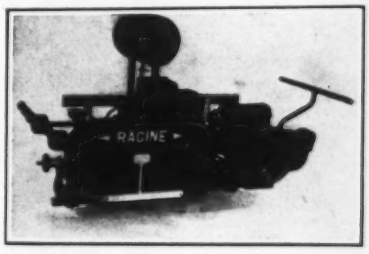
now in production by the Trackson Co., makers of full-crawlers, Milwaukee, Wis. It is a special machine built for slow heavy pulling and has been produced to meet a demand for a tractor between the 2 and 5 ton sizes. The tractor is 75 in. wide, 120 in. long overall, has a rigid frame and weighs 4,100 lb. The track area has been increased to 1,600 sq.in. No changes in the Fordson are necessary and its usual ground clearance is maintained.

New Developments in Push Cars and Diesel Engines

Two new types of push car trailers have been put on the market by the Fairbanks, Morse & Co., Chicago. They are known as Types 4-B and 12-B and each is made in a number of different styles. They are made plain as push cars and equipped with or without brakes, and when made for trailers are equipped with drawbars and with or without brakes, seat tops and foot boards. They are equipped with roller axle bearings, pressed steel wheels and steel faced dump sills. In addition to these new trailers, the Fairbanks, Morse Co. is exhibiting at the Railway Show one of its new small Diesel engine generating sets which have capacities ranging from 18 to 36 kw. The generators furnish direct current at 125 or 250 volts and are suitable for running pumps, windlasses or winches, also for fans and lights. Starting is accomplished by turning over the engine with compressed air, no preheating or auxiliary ignition devices of any kind being required.

Saw for Cutting Battered Ends of Railway Rails

A new model of the Racine high-speed rail cutting machine is to be exhibited at the Railway Show by the Racine Tool & Machine Co., Racine, Wis. These machines are intended pri-



marily for cutting battered ends of rails either in the track or at convenient points along the track. They are equipped with individual gasoline motor drive, electric motors or pneumatic motors. The model shown in the accompanying illustration is for cutting rails 7 in. high and 6 in. wide.

New Publications

Cement—LEHIGH PORTLAND CEMENT Co. has issued a folder containing some convincing photographs and strength data on high early-strength concrete, obtainable "by anyone with the usual concrete materials." Data include test results on concrete work of two mixes with ordinary materials, and that containing calcium chloride. Graphs indicate a strength in 24-hr. concrete of ordinary materials with careful proportioning of 2,270 lb. Photographs of the work are also shown.

Drain Tile—A 4-page circular by the W. S. Dickey Clay Mfg. Co., Kansas City, Mo., entitled "Instructions for Laying Pipe Where Two Lines Are Laid for Mains, One in Each Side of Track," for the guidance of those engaged in laying drain tile in railway work.

Concrete Mixers—THE JAEGER MACHINE Co., Columbus, Ohio, has issued 56-p. and 12-p. pamphlets on tilting and non-tilting mixers of various capacities for concrete, plaster and mortar. Steel and rubber-tired wheels, batch meters, water tanks, concrete distributing chutes and buckets and other special features are included.

Arc Welding—LINCOLN ELECTRIC Co., Cleveland, has published a 23-page catalog devoted to the theory and application of its "Stable-Arc" process and its equipment to automatic arc welding. Different types of machines are illustrated, some for shop installation, others for portability on such work as bottoms and roofs of large oil storage tanks.

Power Shovels—AMERICAN HOIST & DERRICK Co., St. Paul, Minn., devotes its most recent catalog to its model "K" shovel using gasoline, steam or electric power. Specifications and illustrations are included which completely describe the machine.

Spray Painting.—DUNN PAINTING MACHINE Co., San Francisco, has published a booklet describing its atomized painting process and its patented painting machine. Cut-out drawings which are included, graphically indicate the principle upon which the machine works. Tables of cost comparing brush and machine work are given for a number of different kinds of painting jobs. A list of prominent concerns that use Dunn machines is also given in the catalog.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL RAILWAY APPLIANCES ASSOCIATION, Chicago; Annual meeting, Chicago, March 7-10, 1927.

NATIONAL BATTERY MANUFACTURERS' ASSOCIATION, New York; Annual meeting, Philadelphia, March 11 and 12, 1927.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Annual Meeting, White Sulphur Springs, West Va., March 21-23.

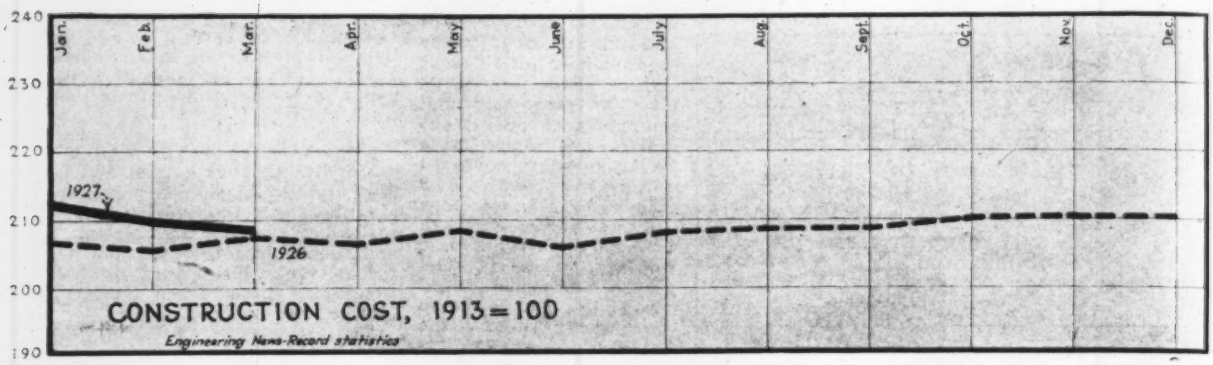
SOUTHERN PINE ASSOCIATION; New Orleans; Annual meeting, New Orleans, March 22-23.

HYDRAULIC SOCIETY, New York; Annual meeting Chicago, March 25, 1927.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

Engineering News-Record Statistics of the Construction Industry

Mar. 3, 1927 — *in the United States* — Vol. 98, No. 9



Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

January, 1926 to Date

March, 1927	**208.80**
February, 1927	210.15
March, 1926	207.65
Peak, June, 1920	273.80
1913	100.00

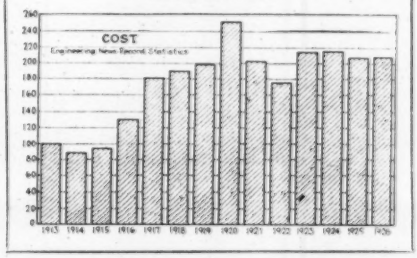
1926

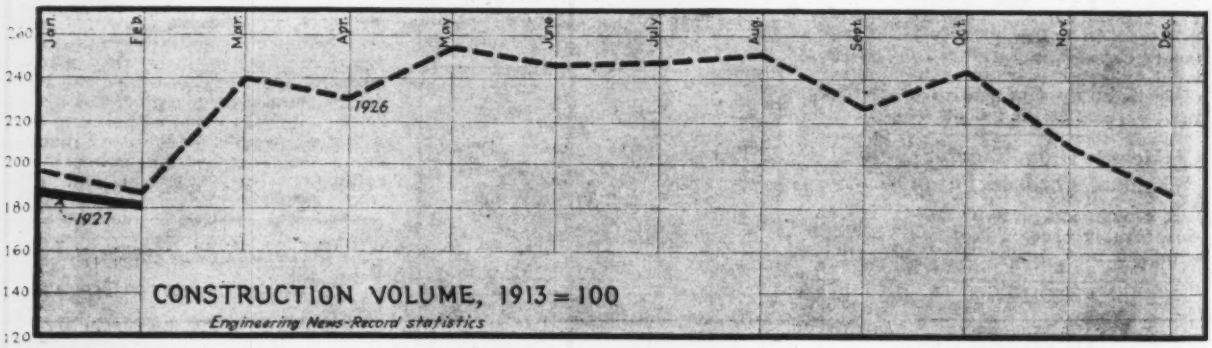
Jan.	207.15	May	207.30	Sept.	208.30
Feb.	206.55	June	204.80	Oct.	209.80
Mar.	207.65	July	207.80	Nov.	210.80
April	207.05	Aug.	208.30	Dec.	210.80

January, 1927 ..... 211.50

Engineering News-Record's Construction Cost Index Number is 0.6 per cent below February, 1927. The decrease is due mainly to lower prices for steel and cement, offsetting higher labor costs. The average rate for common laborers is 56c. per hr., against 54½c. at this time last year. Thus, general construction cost is 0.5 per cent above March, 1926, 24 per cent under the peak and 108 per cent above 1913.

YEARLY
1913 to 1926





Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY

January, 1926 to February, 1927

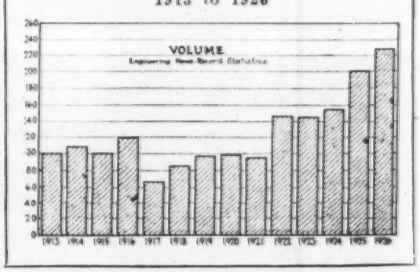
February, 1927	**182**
January, 1927	187
February, 1926	187
Peak, August, 1925	266
1913	100

1926

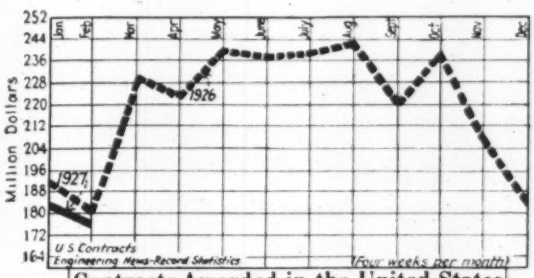
Jan.	198	May	254	Sept.	227
Feb.	187	June	246	Oct.	244
Mar.	240	July	248	Nov.	211
April	233	Aug.	252	Dec.	188

Engineering News-Record's Construction Volume Index Number is 182 for the month of February and 228 for the whole of 1926, as against 100 for 1913. This means that the actual volume of contract letting in 1926 (not the mere money-value of the contracts let that year) is 128 per cent above the volume for 1913. The monthly volume number, 182 for February, 1927, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

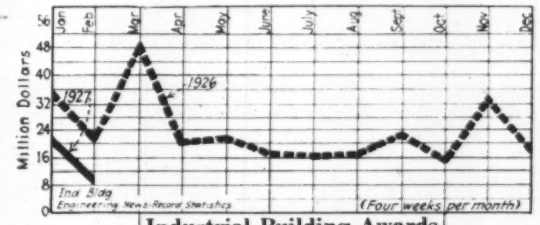
YEARLY
1913 to 1926



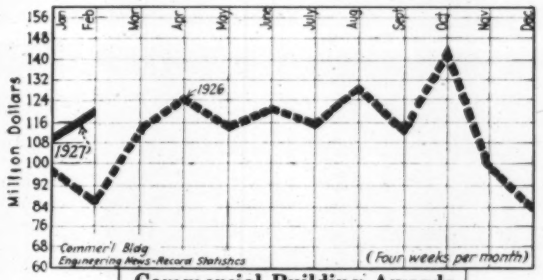
Monthly Statistics of the Construction Industry



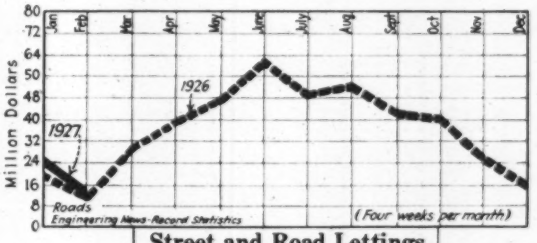
Contracts Awarded in the United States
Reported by E. N.-R.



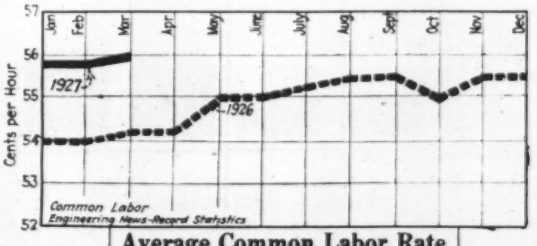
Industrial Building Awards
$40,000 and Over



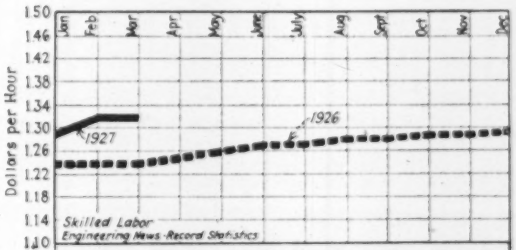
Commercial Building Awards
$150,000 and Over



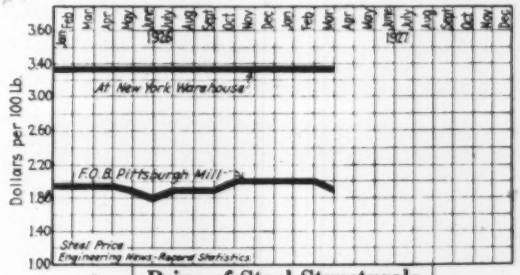
Street and Road Lettings
$25,000 and Over



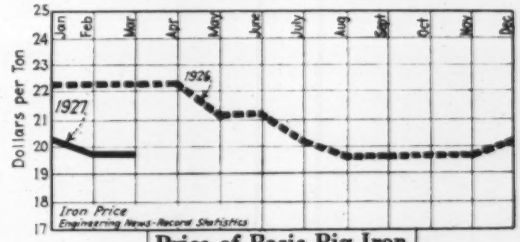
Average Common Labor Rate
Pick and Shovel Men



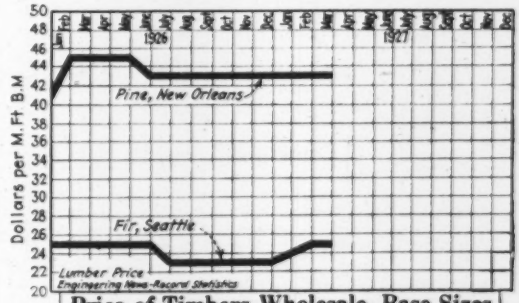
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



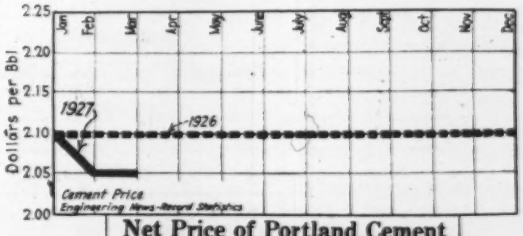
Price of Steel Structurals
Shapes 3-in; Plates ¼-in.



Price of Basic Pig Iron
F.o.b. Pittsburgh

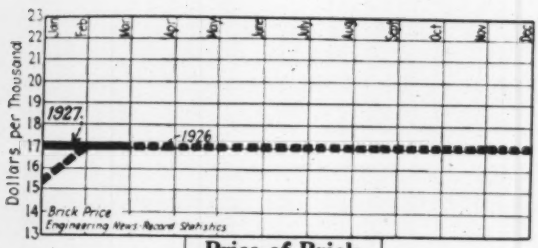


Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

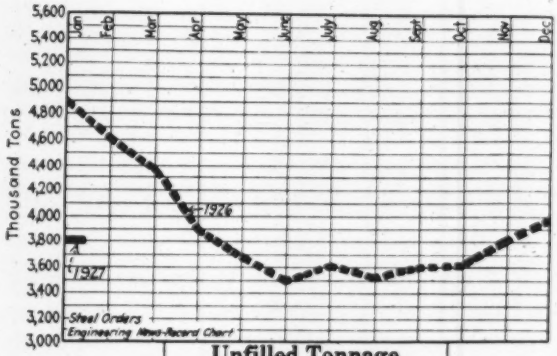


Net Price of Portland Cement
Car Lots F.o.b. Chicago

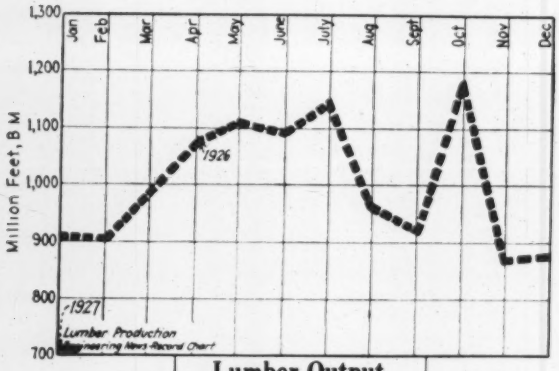
Monthly Statistics of the Construction Industry



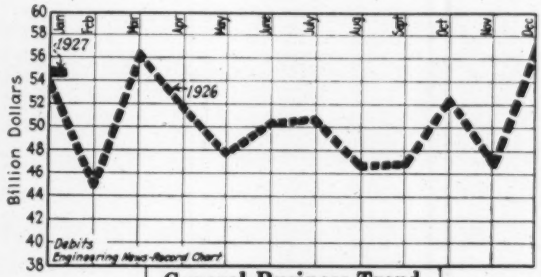
Price of Brick
At Dock, New York



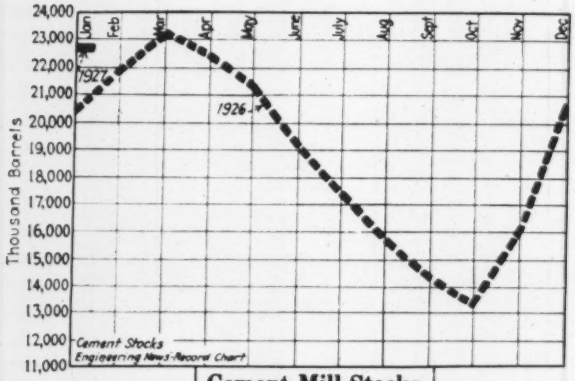
Unfilled Tonnage
On Books of U. S. Steel Corp.



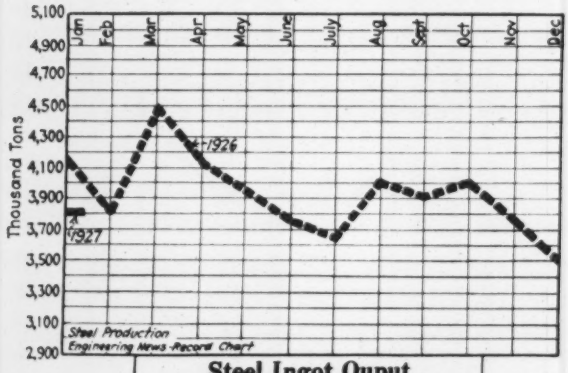
Lumber Output
Nat. Lumber Mfrs. Assn.



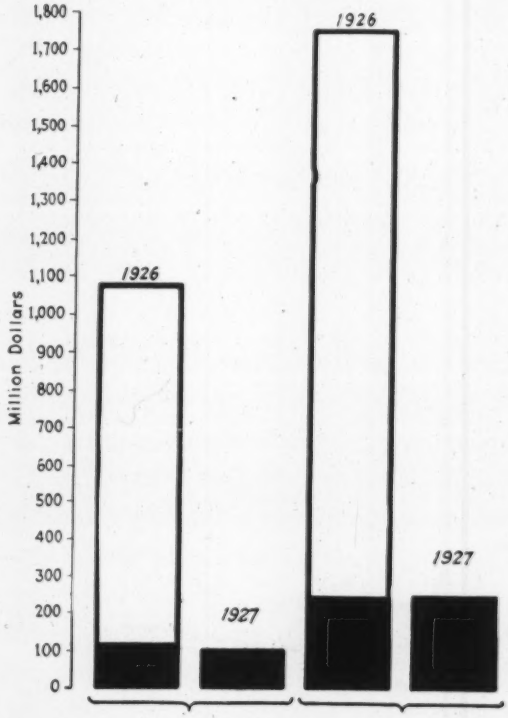
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Stocks
Bureau of Mines



Steel Ingot Ouput
Gross Tons; Am. Iron and Steel Inst.



Public—Contracts—Private
Jan. 1 to date ——
Reported by E. N.-R.

New York City's Part in Nation's Building Situation

Over-Expansion During 1925 in Structures Other than Industrial Now Being Felt Locally

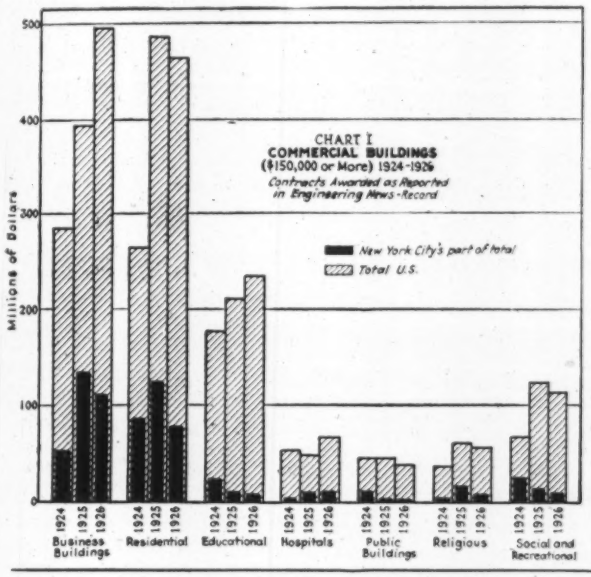
ANALYSIS of New York City's construction program during the past three years shows that the recent warnings against overbuilding were prompted by the tremendous program of 1925 rather than by current contract letting.

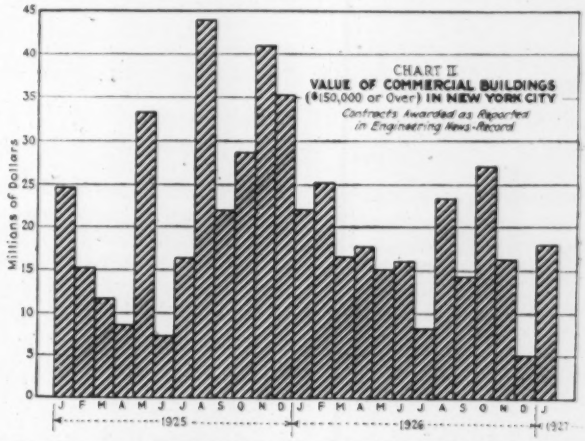
The slowing up of construction volume, as measured by the aggregate of commercial building contracts awarded of $150,000 or more is evidenced by a drop of 30 per cent from the 1925 value. As seen in Chart I, every classification except hospitals participated in this decrease—large residential building falling even below the 1924 amount. Month to month fluctuations indicate that the decline was fairly consistent throughout the year. There was a moderate pick-up in the fall, but the December volume shrank to the lowest total for two years.

January, 1927, comes up to the monthly average of 1924 and 1926, but whether this is to be considered normal for New York is difficult to say. The year 1925 was one of big projects—74 of the 231 buildings costing $1,000,000 or more. The average contract value was $1,380,000 compared with $910,000 in 1926. These large projects take a year or more to complete. Many of them have just recently been finished and are only now beginning to have their effect on the real estate market. The readiness with which this new floor space is being absorbed will be one of the critical factors in determining what New York's construction volume will be this year.

It is surprising that in spite of such a large decrease in the largest metropolis, the country as a whole more than held its own in the total value of contracts awarded during 1926. The following table gives an idea of New York's importance in the three major classifications of commercial buildings, compared to the rest of the country:

	Per Cent Increase (+) or Decrease (—) 1925-1926		
	U. S. (N. Y. City Excepted)	N. Y. City	Entire U. S.
Business Buildings	+51	—20	+26
Large Residential	+ 7	—38	— 5
Educational Buildings	+14	—34	+12
Total, other classifications included	+20	—30	+ 8





February Proposed Work Gains Despite Drop in Construction Contract Letting Compared with First Month of the Year

AWARDING of contracts for heavy engineering construction in the United States during February, showed a drop of 3 per cent compared with the same month last year.

This is offset, however, by an increase of 33 per cent in work proposed during the last month, compared with February, 1926.

Despite the slight decline in money value of contracts let in February, from the total of the month preceding, as shown in the accompanying table, marked activity in both proposed work and awards is noted in water-works, sewers, bridges, and various unclassified jobs. Contracts show gains in commercial buildings and excavating projects while proposed work reflects an upward turn in volume of industrial and public buildings.

Twenty-two states registered higher contract totals last month, than for the first month of the new year, these were, Maine, Vermont, Rhode Island, New Jersey, West Virginia, Georgia, Florida, Alabama, Mississippi, Tennessee, Indiana, Wisconsin, Missouri, Arkansas, North Dakota, Nebraska, Oklahoma, Texas, Colorado, Idaho, Nevada, and Washington.

In arriving at the totals shown in the table, the following minimum was adopted in each case: water-works and excavations, drainage, irrigation, harbor work, etc., $15,000; other public lic works, $25,000; industrial buildings, $40,000; commercial, educational, religious and other buildings, $150,000.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING FEBRUARY, 1927

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date U.S.	Canada
Waterworks	$39,000	$254,000	$84,000	$2,522,000	$826,000	$952,000	$4 677,000	$7 357,000	$59,000
Sewers	40,000	1,050,000	332,000	3,019,000	401,000	1,511,000	6,353,000	11,050,000	620,000
Bridges	27,000	3,208,000	488,000	.....	648,000	1,254,000	5,625,000	9,786,000	.....
Excavation, Drainage, Irrigation	.....	28,000	87,000	85,000	588,000	156,000	944,000	1,547,000	.....
Streets and Roads	93,000	2,943,000	2,942,000	648,000	2,560,000	3,199,000	12,385,000	36,618,000	60,000
Industrial Building	1,105,000	1,313,000	980,000	2,535,000	2,272,000	1,348,000	9,553,000	31 131,000	.....
Commercial Building	7,500,000	30,714,000	11,693,000	35,000,000	18,928,000	16,585,000	120,420,000	231,705,000	2,575,000
Federal Government	.....	1,501,000	55,000	23,000	124,000	49,000	1,752,000	5,577,000	.....
Unclassified	1,133,000	1,428,000	4,347,000	2,000,000	3,776,000	877,000	13,461,000	22,239,000	280 000
February, 1927	$9,937,000	$42,439,000	$21,008,000	$45,832,000	$30,123,000	$25,931,000	$175,270,000	$357 010,000	$3,594,000
January, 1927	18,525,000	51,381,000	12,716,000	40,104,000	24,441,000	34,573,000	181,740,000	.....	5,028,000
January 1 to date, 1927	28,462,000	93,820,000	33,724,000	85,936,000	54,564,000	60,504,000	357,010,000	.....	8,622,000
January 1 to date, 1926	16,829,000	134,414,000	57,308,000	78 359,000	46,074,000	37,695,000	370,679,000	.....	12,136,000

Labor Rates and Conditions Throughout the Country

Important Settlements During Month

DEVELOPMENTS in the building trades labor market during the last month include three important settlements, namely, the addition of two more cities to the movement for the five-day week, increased opposition to the latter on the part of employer organizations, and demands for increased wage rates in two large industrial districts.

Foremost among the agreements stands the one entered into by the bricklayers and plasterers, with Elihu Root acting as arbitrator. This adjustment was nation-wide in scope and restored to effectiveness all signed agreements existing between the two trade unions over a period of sixteen years. The trouble arose over the question as to which trade had jurisdiction over the organization of new plasterers' locals in various parts of the country especially since bricklayers unions in some instances included plasterer members.

The notorious San Francisco carpenters' strike ended officially on Feb. 18, 1927, with the acceptance of the open-shop plan by the Bay District Council of Carpenters and the establishment of the Impartial Wage Board's rate of $1.12½ per hr. for an eight-hour day in this trade.

The third important action in the labor field was that involving the official expulsion on Feb. 3, of eight officers of New York Local No. 3, International Brotherhood of Electrical Workers, on charges of corruption.

Existing wage agreements in the Indianapolis building trades will expire between now and April 1, at which time demands for the five-day week are expected to be pushed forward. The mechanics will probably not request higher hourly wage rates than those now in effect.

The Allied Building Trades Council of Baltimore plans to put a five-day week into effect July 1, 1927. A report to this effect has been made to the Baltimore Federation of Labor by a council delegate. It is not expected that employers of union labor will make a vigorous protest, although they are reported opposed to the plan.

Resistance to the 40-hr. week in the building trades is especially strong among building trades employers in New York, Ohio and Illinois but as yet no noticeably united front against the labor unions has been offered.

Electrical workers in Newark, N. J. are moving for a wage advance of $2 per day to take effect May 1, 1927. This would bring the scale to a daily rate of $14.

Ornamental iron workers in Kansas City, Mo., are asking an increase of 12½c. per hr. to become effective May 1, 1927. Structural iron workers also talk of a similar move, while both crafts have the five-day week in mind. Hod carriers contemplate demanding a wage increase and the 40-hr. week later in the season.

Current Building Trades Wage Rates Per Hour

(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.40	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½@1.75	1.00@1.10	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00@1.50	.40@1.05	.75@1.00	50@.75	.....	.75@1.75	.25@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.45@.74
Cincinnati	1.50	1.31¼	1.31¼	.95	1.31¼	1.31¼	.45@.58
Chicago	1.62½	1.10@1.50	1.00@1.50	.90@.96¼	1.50	1.50	.90
Cleveland	1.50	1.25	1.30	.87½@1.10	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	1.00	1.00	.30@.50
Denver	1.62½	1.25	1.12½@1.18¾	.81¼@.87½	1.00	1.15⅝	.40@.55
Detroit	1.50	.90@1.15	.85@1.00	.90	.85@1.00	1.12½	.50@.60
Kansas City, Mo	1.50	1.25	1.25	.90	1.25	1.25	+.40@.75
Los Angeles	1.37½	1.00	1.00	.87½	.87½	1.00	.50
Minneapolis	1.25	.87½@95	.87½	75	....	1.00	.45@.60
Montreal	1.25	.75	.60	.40	.50	.75	.25
New Orleans	1.50	.90	1.00	.75	.80	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90⅛
Philadelphia	1.50@1.62½	1.12½@1.25	1.02½	1.12½	1.00	1.12½@1.25	.45@.50
Pittsburgh	1.62½	1.50	1.37½@1.50	1.12½	....	1.50	.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.45@.75
San Francisco	1.37½	1.12½	1.00@1.06¼	.87½	1.12½	1.37½	.50@.60
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½	.62½

Monthly Prices of Construction Materials

Seasonal Firmness Noted

THE definitely downward price movement of a month ago appears to have been checked during the last few weeks.

Several important advances are noted in the current price tabulation, involving principally re-rolled rails, railroad spikes, track bolts, road oils, concrete aggregates, hollow building and partition tile, structural rivets, boards, timbers and dimension lumber in the important centers.

The declining tendencies of the February market are still evident in scrap metals, lime, structural steel shapes, plates, reinforcing bars, wire nails, and steel sheets.

Increasing price firmness, apart from that induced by seasonal increase in construction activity, is developing in lumber and common brick. In the case of the former, production is declining while demand gains. In the latter, reserve stocks of burned brick at plants are expanding, while volume of orders seem to be sufficiently large to accommodate the excess. Lumber prices are therefore firmer and those of brick steady.

Cement, output is normally slower at this time of the year, compared with the summer month, which is in conformity with the movement in demand. The present situation at cement mills throughout the country, makes for continued stability in prices.

Declining orders with increased ingot output marks the position of steel in the current building materials market. Further easing of prices may be expected unless the February bookings show a heavier increase in tonnage that occurred a year ago.

"Engineering News-Record Construction Costs" from 1910 through 1926—48 pages of prices, labor rates, index numbers, and unit costs on 50 actual jobs of 1926—now on the press. Next week you will find here the table of contents of this valuable compilation.

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	March 3	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$22.19	$24.02
Northern Basic	20.89	24.27
No. 2 Southern Ohio (silicon 1.75@2.25)	21.39	24.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	26.37	28.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	18.50	22.00@23.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	23.26	24.16
Virginia No. 2 (silicon 2.25@2.75)	28.17	29.17
Basic	21.76	23.16
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.00	23.00
No. 2 Foundry Southern (silicon 2.25@2.75)	24.55	26.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	22.27
Basic	19.76	22.27
Bessemer	21.26	22.27

SCRAP—The prices following are f.o.b. per net ton paid by dealers:

	New York*	Chicago	Birmingham
No. 1 railroad wrought	*$12.50@$13.50*	*$11.75@$12.25*	$12.00@$13.00
Stove plate	*8.50@10.75*	*13.50@14.00*	14.00@14.50
No. 1 machinery cast	15.00@16.00	16.00@16.50	17.00@17.50
Machine shop turnings	*7.75@8.25*	6.00@6.50	8.00@8.50
Cast borings	*8.25@13.00*	*9.00@9.50*	8.00@9.00
Railroad malleable	*14.00@14.25*	*14.00@14.50*	16.00@17.00
Re-rolling rails	*12.00@12.50*	*14.00@14.50*	15.00@16.00
Re-laying rails	23.00@24.00		21.00@22.00
Heavy melting steel	*8.50@11.75*	*11.50@12.00*	13.00@14.00

*Gross ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh March 3	Pittsburgh One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.		36@38	34@36	1.80@1.90*	2.05-2.15*
Light rails, 12 to 14 lb.		36.00	34@36	1.80@1.90*	1.88-1.98*
Light rails, 25 to 45 lb.	36.00	36.00	34@36	1.80@1.90*	1.84-1.94*
Re-rolled rails	34.00	30@34	30.00	34@36	

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.85	2.45
Chicago, zinc treated	1.65	2.15
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.20	1.45
St. Louis, zinc treated	1.60	1.85
St. Louis, red oak, plain	1.10	1.35
St. Louis, sap pine-cypress	.95	1.20
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh March 3	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅞-in. and larger	$2.80@$3.00	$2.80	$3.55	$3.65	$4.35	$3.00
Track bolts	3.90@4.50	3.90@4.15	4.55	4.60	5.85	3.90
Standard section angle bars, splice bars or fish plates	2.75	2.75	3.40	3.75	3.60	4.15

Pipe

WROUGHT PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black New York	Black Chicago	Black Birmingham	Black St. Louis
1 to 3 in. butt welded	53%	54%	62%	49%
2½ to 6 in. lap welded	48%	51%	59%	46%

	Galvanized New York	Galvanized Chicago	Galvanized Birmingham	Galvanized St. Louis
1 to 3 in. butt welded	39%	41%	50½%	36%
2½ to 6 in. lap welded	35%	38%	47½%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 35-5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier in carload lots:

	Birmingham	Burlington, N. J.	New York Mar. 3	New York One Year Ago
4 in.	$42.00	$49.00	$51.60	$54.60@56.60
6 in. and over	38.00	45.00	47.60	50.60@52.60

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	$49.60	$50.20	$47.60	$51.00
6 in. and over	45.60	46.20	43.60	47.00

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Mar. 3	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$48.00	$40.00	$45.00		$73.00
4	55.00	60.00	40.00	56.00	$76.50	110.00
5				80.00	97.75	118.00
6	90.00	90.00	70.00	100.00	127.50	150.00
8	160.00	160.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3		$0.08	$0.10	.....	$.088	$0.12	
4		.08	.10	$0.10	.088	.15	$0.15
5		.11	.135	.....	.121	.18	.18
6	$0.24	.11	.21	.14	.121	.21	.21
8	.43	.18	.315	.225	.198	.30	.325
10	.50	.252	.45	.315	.315	.42	.476
12	.65	.324	.54	.405†	.405	.56	.612
15	1.08†	.432	.75	.675†	.54	.92	1.02
18	1.58†	.60	.90	.945†	1.00	1.32	1.53
20	1.89†	.72	1.20	.....	1.20	.....	.....
21	.....	.84	1.25	1.26†	1.40	.....	.....
22	2.52†	.96	1.35	.....	1.60	.....	1.564
24	2.84†	1.08	2.665	1.62†	1.80	2.16	2.04
27	4.65†	2.405	2.952	2.45†	2.75	3.00	3.34
30	5.16†	2.664	3.96	3.00†	3.75	3.60	4.06
33	6.98†	3.60	4.51	3.55†	4.50	.....	4.99
36	8.00†	4.10	5.06	3.95†	5.00	.....	5.42

	3	5	8	12	24	36
Boston	$0.12	$0.175	$0.25	$0.50	$1.90†	$5.20†
Minneapolis			.25	.45	1.50	4.50
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.63	2.52	.....
Los Angeles	.1675	.186	.2825	.504	1.74	.....
New Orleans	.....	.....	.205	.40	2.27	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal	.....	.50	.70	1.35	4.50	.....
Detroit	.111	.1665	.259	.4995	1.665†	3.7925†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15	.21	.29	.52†	1.90†	3.80†
Philadelphia	.11	.16	.26	.42	1.50	3.70

*4-in., 6-in., 9-in., respectively. †Double Strength.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		Mar. 3	One Year Ago
New York, 45% asphalt	(at terminal)	$0.065@$0.075	$0.065@$0.07
New York, 65% asphalt	(at terminal)	.0675@.0725	.0675@.0725
New York, binder	(at terminal)	.07@.075	.07@.075
New York, flux	(at terminal)	.07@.075	.07@.075
New York, liquid asphalt	(at terminal)	.07@.075	.07@.075
St. Louis, 40@50% asphalt		.0583	.0570
St. Louis, 50@60% asphalt		.0598	.0575
Birmingham, 55% asphalt		.0475	.0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 50% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	23.50	$19.00
Chicago (*Texas*)	28.00	23.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Stanolind)*	28.10	22.10
St. Louis (*Mexican*)	27.00	24.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	24.40	*19.40*
Detroit (*Mexican*)	**24.65**	**20.65**
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	28.30	23.30
Los Angeles (*"D" grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

* F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$130.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	4.00 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., $1.05 per lin.ft.; roundings, $1.50. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.45
St. Louis	4	16	2.80
Seattle	4	16	Off market
Minneapolis	3½	16	2.20
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor, f.o.b., per cu.yd., is as follows:

	Gravel 1½ In. Mar. 3	Gravel 1½ In. One Year Ago	Gravel ¾ In. Mar. 3	Gravel ¾ In. One Year Ago	Sand Mar. 3	Sand One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	1.85	1.65	1.85	1.65	1.65	1.50
St. Louis	1.45†	1.45†	1.55–1.65†	1.45†	.83‡†	1.08
Seattle	1.25	1.50	1.25	1.50	1.25	1.50
Dallas	2.38*	2.38	2.38*	2.38	2.00*	2.00
Minneapolis	1.65‡	1.65‡	1.65‡	1.65‡	1.25*	1.25
Cincinnati	1.30†	1.40†	1.30†	1.40†	1.05†	1.35†
San Francisco	1.80	1.80	1.80	1.80	1.40	1.40
Boston (*on trucks at dock*)	1.75†	1.50†	1.75†	1.50†	1.25†	1.00†
New Orleans	2.10†*	2.60	3.00†*	2.60	1.80†	1.75
Los Angeles	**2.00**†	1.15†	**2.00**†	1.15†	*1.40*†	.93‡†
Atlanta	1.90†	1.90†	1.90†	1.90†	**1.60**†	1.50†
Detroit	1.70	2.02	1.60	2.02	1.35	1.62
Baltimore	1.40	1.40	1.60	1.60	.70‡	.70‡†
Montreal	1.50†	1.25†	1.50†	1.25†	1.25†	1.25†
Birmingham	2.00*	2.00	2.00*	2.00	1.50	1.50
Philadelphia	2.25*	2.10	2.25*	2.10	1.65	1.50
Kansas City, Mo.	.....	.....	.....	.....	.66‡†	.66‡†
Pittsburgh	.85‡	.....	.85‡	.....	.....	.....

•Delivered. † Per ton. ‡ At pit.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. cars, as follows:

	1½ In. Mar. 3	1½ In. One Year Ago	¾ In. Mar. 3	¾ In. One Year Ago
New York	$1.84	$1.75	$1.94	$1.85
Chicago	1.70	1.75	1.87½	1.87½
St. Louis	1.93*	1.93*	1.93*	1.93*
Dallas	2.40†	2.40	2.83†	2.83
San Francisco	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	2.10*	1.60*	2.10*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	2.00†	1.50	2.00†	1.50
Denver	2.50†	2.50	2.50†	2.50
Seattle	3.00†	3.00	3.00†	3.00
Atlanta	2.50*†	2.50*	2.50*†	2.50*
Cincinnati	1.65*	1.90*	1.65*	1.90*
Los Angeles	*2.00*†*	1.40*	*2.00*†*	1.40*
Detroit	2.60*†	2.00*	2.60*†	2.00*
Baltimore	2.50†	2.50	2.55†	2.55
Montreal	1.80*	1.80*	2.00*†	1.50
Philadelphia	2.25†	2.10	2.25†	2.10
Pittsburgh	2.75†	2.85	2.75†	2.85
Cleveland	2.70*†	3.25*	2.70*†	3.25*
Birmingham	2.00†	2.00	2.00†	2.00

* Per ton. † Delivered.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.70*	1.70*	.....	1.40*
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18.20	$11.00	$3.50*	$2.10@3.00*
Chicago	20.00	18.00	.....	1.50†
St. Louis	23.50	17.50	.....	2.03*
Boston	18.35	11.50	3.55*	2.25@3.00
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco	25.50	22.00	.....	1.60†
Minneapolis	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.25	11.25	.....	11.75‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	25.00	15.00	2.40†	12.60‡
Baltimore	24.25	.....	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	22.00	13.00	.....	1.40†
New Orleans	24.00	15.00	2.60†	2.25*
Philadelphia	23.00	16.00	.....	.....
Kansas City	18.50	17.50	2.50†	1.80†
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Mar. 3	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.45	1.45
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.75	2.65
St. Louis (Carney)	2.35	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Mar. 3	One Month Ago	One Year Ago
New York, del. by truck	$2.35@$2.50	$2.35@$2.50	$2.50@$2.70
New York, alongside dock to dealers	2.03	2.03	2.15
Jersey City	*2.28*	2.33	2.33
Boston	2.35	2.35	2.40
Chicago	2.05	2.05	2.10
Pittsburgh	2.04	2.04	2.09
Cleveland	2.24	2.24	2.29
Detroit	2.15	2.15	2.15
Indianapolis	2.19	2.19	2.29
Milwaukee	2.20	2.20	2.25
Duluth	2.04	2.04	2.09
Peoria	2.22	2.22	2.27
Cedar Rapids	2.24	2.24	2.34
Davenport	2.24	2.24	2.29
St. Louis	2.05	2.05@2.20	2.20
San Francisco	2.31	2.31	2.31
New Orleans	2.40	2.40	2.40
Minneapolis	2.22	2.22	2.32
Denver	2.85	2.85	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.25	2.35
Cincinnati	2.32	2.32	2.37
Los Angeles	2.50	2.50	2.52
Baltimore	2.50	2.50	2.35
Birmingham	2.40	2.30	2.40
Kansas City, Mo.	2.05	2.05	2.35
Montreal	1.15	1.15	1.80
Philadelphia	2.50	2.50	2.41
St. Paul	2.22	2.22	2.32
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.80	Hudson, N. Y.	$1.75
Universal, Pa.	1.80	Leeds, Ala.	1.85
Steelton, Minn.	1.85	Hannibal, Mo.	1.95
Fordwick, Va.	2.05	Lehigh Valley District	1.75
Mitchell, Ind.	1.90	Wyandotte, Mich.	1.90
Iola, Kan.	1.85	Alpena, Mich.	1.75
Mason City, Ia.	1.80	Kingsport, Tenn.	2.05
La Salle, Ill.	1.90		

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
180	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
PAVING							
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	....	1.14	1.02	.....
067R	31	1.35	1.38	....	1.45	1.39	.....
089R	40	1.74	1.78	....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	$19.50	$17.50	$16.50	$19.00	$24.00
2.5	18.50	21.50	18.50	17.50	21.00	26.00
3.0	21.00	24.50	21.00	20.00	24.00	29.00
3.4	22.50	27.50	22.50	21.50	26.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b., except at New York and St. Louis warehouses:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.90	$2.25	$3.24	$2.30@$2.50	$3.15	$2.75	$2.95
⅝	2.00	2.35	3.34	2.40@2.60	3.25	2.85	3.05
¾	2.10	2.45	3.44	2.50@2.70	3.35	2.95	3.15
⅞	2.30	2.65	3.64	2.70@2.90	3.55	3.10	3.35
1	2.90	3.25	4.24	3.30@3.50	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.35	$2.48	½	$2.75	$2.88
⅝	2.45	2.58	¾	3.35	3.48
¾	2.55	2.68	⅞	....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Mar. 3	One Month Ago	One Year Ago	Paving Block: 3-inch*	3½-inch*
New York (del.)	$20.40–22.40	$20.40–22.40	$21.00	$45.00†	$51.00†
New York (at dock)	17.00	17.00	17.00	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	15.00	15.00	16.00	40.00	42.50
Denver, salmon	9@10	9@10	12.00	.....	.....
Dallas	14.10	14.10	11.10	35.00	.....
San Francisco	15.00	15.00	15.50	.....	.....
Los Angeles	10.50	10.50	11.50	(not used)	
Boston (del.)	19.50	19.50	17.50	45.00	50.00
Minneapolis (del.)	13.75	13.75	13.50	.....	.....
Kansas City	13.50	13.50	14.50	(no market)	
Seattle	15.00	15.00	15.00	.....	55.00
Cincinnati	15.50	15.50	17.00	40.00	45.00
Montreal	20.25	20.25	17.50	100.00‡	.....
Detroit (del.)	16.00	16.00	16.00	38.40	41.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	12.00	12.00	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	60.00	75.00
Birmingham	14.50	14.50	12.50	40.00	45.00
Philadelphia	18.00	18.00	17@21	40.00	50.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	12@14	12@14	14.00	.....	.....

*For paving blocks 3x8¼x4 and 3½x8¼x4 respectively. †In cars. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Mar. 3 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1112	$0.1112	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.1667	.1667	.104	.....	.09	.156	.....
8x12x12	.2084	.2084	.142	.205	.126	.244	.....
10x12x12	.....	.....	.182	.....	.158	.....	$0.252
12x12x12	.....	.....	.202	.....	.188	.....	.312

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.165	$0.27
Minneapolis (f.o.b. cars)	.072	.125	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.154	.252
Denver	.085	.155	.22
Seattle	.09	.18	.26
Los Angeles	.085	.172	.285
New Orleans	.11	.205	.31
Detroit	.0707	.1326	.1853
Montreal	.10	....	.....
Baltimore	.124	.268	.....
Atlanta	.0895	.1837	.....
Dallas	.112	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.062	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb. in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90	$2.05	$3.34	$4.15	$3.25	$3.10	$3.00
Channels, 3 to 15 in.	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Angles, 3 to 16 in., ¼ in. thick	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Tees, 3 in. and larger	1.90	2.10	3.34	4.15	3.35	3.10	3.00
Plates, ¼ in. thick and heavier	1.80@1.90	2.00	3.34	4.15	3.25	3.10	3.00

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York, Mar. 3	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.40@$2.60	$4.20	$4.50	$3.50	$3.65	$5.00	$4.75
CONE HEAD BOILER							
½ in.	2.90	$4.40	$4.70	$3.70	$3.85	$5.20	$5.00
⅝ and ¾	3.05	4.55	4.85	3.80	4.20@4.45	5.35	5.15
⅞ and 1	3.30	4.80	5.10	4.05	4.60	5.60	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.40@$2.60	$2.85	$3.05	$3.50	$4.25	$2.6	$4.95
Cut	2.80	2.90	....	5.00	5.00	5.00	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing (4 ply) in rolls of 108 sq.ft costs $2.46 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $6.36 per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $5.00 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$72.00
Asphalt coating, per gal	.33
Asphalt felt, per 100 lb	3.71

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 87 per cent; "B," 89 per cent. Double thickness "AA," 82 per cent; "A," 86 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.10@2.25	$3.60	$3.50	$3.75	$3.89
No. 12	2.15@2.30	3.65	3.55	3.80	3.94
No. 14	2.20@2.35	3.70	3.60	3.85	3.99
No. 16	2.30@2.45	3.80	3.70	3.95	4.09
Black					
Nos. 18 to 20	$2.65@2.80	4.25	3.75	4.50	4.15
No. 22	2.80@2.95	4.40	3.90	4.65	4.30
No. 24	2.85@3.00	4.45	3.95	4.70	4.35
No. 26	2.95@3.10	4.55	4.05	4.80	4.45
No. 28	3.10@3.25	4.70	4.20	4.90	4.60
Galvanized					
No. 10	$2.95@3.10	4.55	4.10	4.55	4.40
Nos. 12 to 14	3.05@3.20	4.65	4.20	4.65	4.50
No. 16	3.15@3.30	4.75	4.30	4.75	4.60
No. 18	3.30@3.45	4.90	4.45	4.90	4.75
No. 20	3.45@3.60	5.05	4.60	5.05	4.90
No. 22	3.50@3.65	5.10	4.65	5.10	4.95
No. 24	3.65@3.80	5.25	4.80	5.25	5.10
No. 26	3.90@4.05	5.50	5.05	5.50	5.35
No. 28	4.15@4.30	5.75	5.30	5.75	5.60

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York: Mar. 3	New York: One Year Ago	Chicago: Mar. 3	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.84	$0.87	$0.85	$0.88

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Mar. 3	1 Yr. Ago	Mar. 3	1 Yr. Ago
Red	$15.25	$15.25	$16.75	$16.75
White	15.25	15.25	15.25	15.25

Lumber

Prices wholesale, per M. ft. b.m., to contractors in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$42.00@$44.00	$43.00@$45.00	$38.50	$40.50
3x10 to 10x10	49.00@ 51.00	50.00@ 52.00	45.00	40.50
3x12 to 12x12	56.00@ 58.00	57.00@ 59.00	56.00	40.50
3x14 to 14x14	64.00@ 66.00	65.00@ 67.00	....	40.50
3x16 to 16x16	76.00@ 78.00	77.00@ 79.00	....	42.00

New York—Wholesale price of long-leaf yellow pine timbers (rough) to dealers; to contractors, delivered from lighters or cars to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under—P.	8x8-In. x 20 Ft. and Under—Fir*	8x8-In. x 20 Ft. and Under—Hemlock	8x8-In. x 20 Ft. and Under—Spruce	12x12-In. 20 Ft. and Under—P.	12x12-In. 20 Ft. and Under—Fir*
Boston	$48.50	$48.00†	$50.00	$52.00	$58.50	$58.00†
Seattle	....	24.00	....	....	....	25.00
New Orleans	36.00	....	....	....	43.00	....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	55.00	....	....	60.00	65.00
Los Angeles	....	33.00	....	....	....	33.00
Denver	....	34.25	34.25	34.25	....	33.25
Minneapolis	42.50	39.25	34.50	....	45.00	39.25
Atlanta	31.00	....	....	....	34.00	....
Dallas	56.00	....	....	....	56.00	....
Kansas City, Mo.	41.50	39.75	....	....	55.50	39.75
Birmingham	32.00	....	....	....	34.00	....
Philadelphia	54.00	38.00	38.00	45.00	65.00	38.00
Detroit	47.75	46.75	....	....	61.75	46.75
St. Louis	41.00	....	....	....	53.00	....

	1-In. Rough, 10 In. x 16 Ft. and Under—P.	1-In. Rough, 10 In. x 16 Ft. and Under—Fir*	1-In. Rough, 10 In. x 16 Ft. and Under—Hemlock	2-In. T. and Gr. 10 In. x 16 Ft.—P.	2-In. T. and Gr. 10 In. x 16 Ft.—Fir*
Boston	$55.00	$42.00†	$45.00	$49.00	$48.00†
Seattle	....	22.00	....	....	23.50
New Orleans	38.00	46.00	....	28.00	34.00
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	50.00	40.00	65.00	50.00
Los Angeles	....	27.00	....	....	36.00
Denver	....	33.25	33.25	....	30.75
Minneapolis	42.50	35.75	34.75	36.00	33.75
Atlanta	22.00	....	....	28.00	....
Dallas	52.25	....	....	56.00	....
Kansas City, Mo.	50.25	48.75	....	43.75	40.75
Birmingham	27.00	....	....	45.00	....
Philadelphia	30.00	38.00	36.00	35.00	37.00
Detroit	39.75	37.00	....	46.50	41.25
St. Louis	43.00	....	....	29.00	....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers price to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M.ft. additional.

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Mar. 3	One Month Ago	One Year Ago
$2.25@$2.30	$2.25@$2.30	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.18*
Detroit	.16	Boston	.20
New Orleans	.25*	Minneapolis	.14*
New York (Brooklyn)	.18@.20	Philadelphia	.18@.20
Pittsburgh	.16		

*F.o.b.

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¼-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	$0.22	New Orleans	$0.21
New York	.24½	Los Angeles	.25
Chicago	.23	Seattle	.22
Minneapolis	.25	St. Louis	.24
San Francisco	.22½	Montreal	.17
Atlanta	.30	Detroit	.24½
Denver	.24@.25	Baltimore	.18
Cincinnati	.21	Kansas City	.29
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.287½*
Boston	.245	.265
Kansas City	.2025	.2225
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1875
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500. lb. and less than a ton

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	4.80@4.90
Soda ash, 58%, in bags, per 100 lb.	1.32½@1.37½
Chlorine, liquid, tanks, per lb.	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.